SPECIAL ISSUE CONTAINING THE PRELIMINARY ANNOUNCEMENT OF THE FIFTH BOSTON MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND ASSOCIATED SOCIETIES, DECEMBER 27, 1933, TO JANUARY 2, 1934. EDITED BY DR. HENRY B. WARD, PERMANENT SECRETARY

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

PRELIMINARY ANNOUNCEMENT OF THE FIFTH BOSTON MEETING

Edited by Dr. HENRY B. WARD

PERMANENT SECRETARY

THE ninety-third meeting of the association will be held in Metropolitan Boston, beginning on Wednesday, December 27, 1933. While this is regarded as the fifth Boston meeting, it is actually the sixth time that the association has met in the Boston-Cambridge area, the second meeting having been held in Cambridge in 1849.

For the 1933 meeting the official headquarters will be at the Hotel Statler, Boston, where the first general session, as well as a number of special events of importance, will be held. All the fifteen sections and a large number of associated and affiliated societies will meet at this time.

The institutions welcoming the association are Harvard University, Massachusetts Institute of Technology, Simmons College, Boston University, Boston College, Northeastern University, Tufts College, Wellesley College and Weston College. Thus the colleges and universities in the whole metropolitan area will participate as hosts to the visiting scientists, although for general convenience the section sessions will be held in Cambridge in the lecture rooms at Harvard and at the Massachusetts Institute of Technology.

HOTEL HEADQUARTERS

General headquarters for the association, including sections, will be at the Hotel Statler. Rates quoted for rooms, single occupancy, with bath, are $3.50; double occupancy, $5.50 to $6.00. Since not all can be accommodated at the Hotel Statler, a large number of the other Boston hotels in the vicinity of

Copley Square, easy of access to the Statler and to the transportation lines to Cambridge, are available. Headquarters for the various sections and special societies have been assigned as follows:

Statler: American Society of Zoologists; American Society of Parasitologists; Botanical Society of America; American Society of Plant Physiologists; American Microscopical Society; American Society of Naturalists; Genetics Society of America; Econometric Society; Society of the Sigma Xi; Honor Society of Phi Kappa Phi; Gamma Alpha Graduate Scientific Fraternity; Phi Sigma Society; Pi Gamma Mu, National Social Science Honor Society, Inc.; Sigma Delta Epsilon Graduate Women's Scientific Fraternity.

Avery: American Society of Agronomy; Potato Association of America.

Bellevue: American Nature Study Society.

Bradford: American Association of Economic Entomologists; Entomological Society of America.

Kenmore: Engineering Section (M); Medical Sciences Section (N).

Lenox: Ecological Society of America.

New Parker House: American Physical Society; American Association of Physics Teachers; History of Science Society.

Victoria: American Meteorological Society.

Westminster: American Phytopathological Society; Mycological Society of America.

Continental (Cambridge): American Astronomical Society.

Commander (Cambridge): American Mathematical Society; Mathematical Association of America; American Society for Horticultural Science.

Transportation to Cambridge

The Boston Elevated Railway, by its subways and surface lines, offers convenient transportation between Boston and Cambridge. In addition there will be special bus service operating in both directions between Hotel Statler and Copley Square and the buildings at Harvard where the sessions are held, with stops at the Institute of Technology en route.

Under the auspices of the local committee various special committees are arranging a number of social events especially for the entertainment of visiting ladies, including visits to museums, Wellesley, Radcliffe, etc.

The Boston area is too well known to require extended description. Historically, educationally and by virtue of its geographic position, it is familiar to many, perhaps to most, American scientists. Itself of great historic interest, its nearness to Plymouth, Salem, Lexington and Concord, and other places interwoven with early colonial life and patriotism make it a center of unusual significance to all Americans.

While Boston as a political unit is a city of approximately 800,000 people, the thirty cities and towns of the metropolitan area, all within a radius of fifteen miles, make the real or "greater" Boston the fourth city of the United States in population, with two and a quarter million people. Its commercial significance, based on the essential industries of wool, cotton, boots and shoes, paper, machinery, etc., is also well known.

Its beautiful park system, excellent harbor, ease of access to mountain, seaside and charming rural districts need only be mentioned at this time. To those who will attend the Boston meeting this year under winter conditions its significance as an educational and scientific center will perhaps be the chief fact of importance, for Boston is the greatest educational center of the western world, including within its limits or within a radius of 50 miles not only the institutions which will act as hosts on this occasion, but numerous other colleges, schools of music and art, preparatory and vocational schools. The attendants at these institutions would of themselves constitute a city of many tens of thousands.

Among the places of interest in Boston and Cambridge may be mentioned the Peabody Museum, Germanic Museum, Fogg Art Museum, Astronomical Observatory and Botanic Garden, at Harvard; the Nautical Museum at the Massachusetts Institute of Technology; the Boston Art Museum, Gardner Museum, Boston Public Library, Boston Natural History Society, State House (historic collections), Old State House, Watertown Arsenal, Navy Yard, Bunker Hill, Old South Church, Paul Revere House, etc. An illustrated booklet descriptive of Boston and its environs will be supplied to each registrant through the courtesy of the Boston Chamber of Commerce.

S. C. PRESCOTT

Railroad Rates

Reduced railway rates on the certificate plan have been granted by almost all railroads in the United States and Canada. Persons attending the meeting should purchase a first-class, one-way ticket to Boston, securing a standard certificate form reading "For the American Association for the Advancement of Science and Associated Societies." The certificate must be left at the validation desk in the registration office, to be called for later in the same place. Each person presenting an endorsed and validated certificate may purchase a continuous passage, one-way ticket for one third of the regular fare to return by the same route used before. Tickets to Boston must be purchased between December 21 and December 23, both dates inclusive. Return tickets must be purchased by January 5.

Special fares have been announced by the Central and Trunk Line passenger associations. Tickets will be

on sale from December 14 to January 1 with a return limit of January 15, 1934; the round-trip fare is on the basis of one and one ninth times the regular first-class, one-way fare. The Transcontinental and Western lines will have special fares, which will be about the same as already announced by the Central and Trunk Line Associations. The territories of the latter include roughly points from Washington, D. C., to Saint Louis, Cincinnati and Louisville on the south; New York, Albany, Buffalo, Detroit and Chicago on the north; Atlantic seaboard on the east; the Mississippi River on the west, and all intermediate territory.

Possible further reduction of fares and the various periods when going tickets may be purchased on the certificate plan make it advisable to consult the local ticket agent.

REGISTRATION

The main registration headquarters will be at Memorial Hall, Harvard University, where registration facilities will be opened on Wednesday, December 27, and maintained throughout the meeting. A subsidiary registration desk will be conducted in the main lobby of the central building of the Massachusetts Institute of Technology, especially for the benefit of members of the engineering and other sections, meetings of which will be held at the institute. Any one interested in the advancement of science or education may register upon payment of the registration fee of $1.00.

Each registrant receives a copy of the General Program, an identification card and a badge. Registration is necessary to obtain validation of certificates for reduced railway fares. Each registrant is entitled to the validation of his own railway certificate. At the registration desk reservations may be made for all excursions and banquets. The registration desk will also handle all mail, telegrams, etc., and furnish information as desired.

GENERAL SESSIONS

The public program of the meeting will be opened on Wednesday evening, December 27, at 8:30 by the first general session, which is to be held in the Grand Ballroom of the Hotel Statler. Dr. Henry Norris Russell, president-elect, will preside. The association will be duly welcomed to Boston by speakers representing the city and its major educational institutions, to which welcome President Russell will respond. He will then introduce Dr. John Jacob Abel, retiring president, who will deliver his address, "On Poisons and Disease, and Some Experiments with the Toxin of the *Bacillus tetani*." At the close of the formal program the local committee is to tender a reception to the officers and members of the association on behalf of the city and cooperating institutions. This reception will be held in the Hotel Statler and will be participated in by citizens of Boston and vicinity invited by the local committee as well as by all members of the association and its affiliated societies and all others registered for the meeting.

On Thursday evening at 8:30 will be given the annual Sigma Xi address. The speaker this year is Dr. Henry E. Sigerist, professor of the history of medicine and director of the Institute of the History of Medicine at the Johns Hopkins University, on the topic, "The Foundation of Human Anatomy in the Renaissance."

On Friday evening at 8:30 the sections on Engineering (M), Social and Economic Sciences (K), and Agriculture (O) have arranged for a general session on the subject, "What Can Engineering Do for Agriculture?" The address will be given by the Secretary of Agriculture, the Hon. Henry Agard Wallace. He will present a powerful statement on this most important problem, and his coming is bound to arouse deep interest in the occasion.

On Saturday evening, December 30, at the Hotel Statler, the American Academy of Arts and Sciences, in a joint meeting with Sections D and B, will present the Rumford Medal for distinguished research in physics to Professor Harlow Shapley, director of the Harvard Observatory. Dr. Shapley's address on this occasion will be on the subject, "The Anatomy of a Disordered Universe."

The annual dinner and meeting of the American Society of Naturalists will occur Saturday evening. The society is celebrating this year its semi-centennial. The address of the occasion is to be delivered by the retiring president, Dr. B. E. Livingston, professor of plant physiology at the Johns Hopkins University.

VICE-PRESIDENTIAL ADDRESSES

The addresses of the retiring vice-presidents of the various sections are to be delivered according to the following schedule:

Section on Medical Sciences (N): Wednesday, 10:30 A. M. Dr. C. R. Stockard, of Cornell University, on "The Internal Secretions and Genetic Quality in Structural Development."

Section on Geology and Geography (E): Wednesday, December 27, 11:00 A. M. Professor Wm. H. Hobbs, of the University of Michigan, on "The Glaciers of Mountain and Continent."

Section on Social and Economic Sciences (K): Wednesday afternoon. Professor William F. Ogburn, of the University of Chicago, on "Trends in the Social Sciences."

Section on Historical and Philological Sciences (L): Wednesday afternoon. Dr. Waldo G. Leland, of the American Council of Learned Societies, on "Trends in the Humanities."

Section on Botanical Sciences (G): Thursday afternoon, December 28. President H. L. Shantz, of the University of Arizona, on "Botanical Research."

Section on Mathematics (A): Friday morning, December 29. Dr. H. H. Mitchell, of the University of Pennsylvania, on "Linear Groups and Finite Geometries."

Section on Chemistry (C): Friday, 2:00 P. M. Dr. Frank C. Whitmore, of Pennsylvania State College, on "The Polymerization of Olefins."

Section on Zoological Sciences (F): Friday, 6:00 P. M. Dr. A. S. Pearse, of Duke University, on "Ecological Segregation."

Section on Psychology (I): Friday, 6:00 P. M. Dr. Walter S. Hunter, of Clark University, on "Consciousness and Habit Formation."

Section on Education (Q): Friday, 6:00 P. M. Dr. Stuart A. Courtis, of the University of Michigan, on "Differential Testing as a Method of Psychological Analysis."

Section on Anthropology (H): Friday, 6:30 P. M. Dr. C. H. Danforth, of Stanford University, on "Genetics and Physical Anthropology."

Section on Physics (B): Friday. Dr. David L. Webster, of Stanford University, on "Current Progress in X-Ray Physics." Hour not set.

Section on Agriculture (O): Saturday, December 30, 2:00 P. M. Dr. J. H. Gourley, of the Ohio Experiment Station, on "Plant Anatomy as a Tool in Agricultural Records."

Section on Engineering (M): Saturday, December 30, 10:00 A. M. Dr. Dugald C. Jackson, of the Massachusetts Institute of Technology, on "The Origins of Engineering."

Section on Astronomy (D): Dr. Paul W. Merrill, of Mount Wilson Observatory, on "Invisible Starlight." Time not given.

General Lectures

The Hector Maiben Lecture will be given this year by Dr. William Morris Davis, professor emeritus of Harvard University, at 4:30, Thursday afternoon, December 28. Professor Davis has announced his subject as "The Faith of Reverent Science."

Professor Lafayette B. Mendel will give an address on Friday evening before the Section on Chemistry (C) and the Northeastern Section of the American Chemical Society on "The Challenge of Nutrition to the Chemist."

Dr. Henry Fairfield Osborn, of the American Museum of Natural History, has accepted the invitation to deliver the Sedgwick Memorial Lecture under the auspices of the biological department of the Massachusetts Institute of Technology. The lecture will be given in the large Lecture Hall at the Massachusetts Institute of Technology, Cambridge, on Friday afternoon. Dr. Osborn will speak on "Aristogenesis, the Creative Principle in the Origin of Species."

The Gibbs Lecture will not be given this year. This lectureship was established by the American Mathematical Society in 1923. All the expenses are borne by that society and all arrangements are made by it. The lectures have been greatly appreciated by a constantly increasing group of scientific men, and it is hoped that they may be continued another year.

Special Features

The Committee on the Place of Science in Education was instructed by the council of the association to provide a special program for the Boston meeting. Accordingly, sessions have been arranged for Friday, December 29. The principal features of the occasion were reported in SCIENCE for November 3. The event has attracted wide-spread attention, and various organizations of science teachers are cooperating by sending official delegates. However, the meetings are not planned for delegates only; all science teachers and others interested are cordially invited to attend and to participate. A conference luncheon has been arranged with a program of special interest to science teachers.

Social Events

The joint smoker of the biological societies, which is listed this year for 9 to 11 P. M., Thursday, has long been one of the major social features of the meetings. As usual, the event has been timed so as to avoid conflicts with items announced for early evening hours.

In accordance with the established sequence the Sigma Xi dinner is scheduled for Thursday evening before the Sigma Xi address. Other dinners which have also been located on Thursday evening are those of societies in the fields of astronomy, ecology, entomology, mathematics, plant physiology and phytopathology. On Friday evening group dinners are announced for anthropology, botany, chemistry, horticulture, psychology and education and zoology. Saturday evening has been selected for the dinner of the American Society of Naturalists.

Tentative arrangements have been made for other gatherings not yet definitely located in time or place. Full details concerning these events will be found in the final program to be secured on registration in Boston. Many organizations are planning to have reservations made and tickets sold at the general registration booth at Memorial Hall, Harvard University, Cambridge.

Science Exhibition

The 1933 Science Exhibition will be held in Memorial Hall, Harvard University, from December 27 to 30, inclusive. Extensive and interesting research, commercial and secondary school exhibits have been arranged and also, as last year, a science library which will include, in addition to the science books of

the year, the science periodicals as well. A special committee, representing the New England Biological Association, the New England Association of Chemistry Teachers, the Association of Mathematics Teachers in New England and the Eastern Association of Physics Teachers, is providing interesting exhibits and demonstrations of special value to science teachers.

The lounge in the exhibit hall will be the common gathering place and social center. Special demonstrations will be held daily in the New Lecture Hall at the tea hour.

Professor Henry Crew has been selected as chairman of the advisory committee.

Sectional and Society Programs

The Section on Mathematics (A), the American Mathematical Society and the Mathematical Association of America will meet from Wednesday, December 27, to Saturday, December 30, 1933.

The American Mathematical Society will hold sessions on Wednesday and Thursday. The separate sessions of the Mathematical Association will be held on Friday afternoon and Saturday morning. One of these sessions will be devoted to mathematical logic and will include addresses by Professor Alfred N. Whitehead and Alonzo Church. A special feature of the meetings will be a symposium on "General Analysis," organized by the Mathematical Society. The chief speaker will be Professor T. H. Hildebrandt, and there will be papers also by Professors R. W. Barnard and M. H. Stone. A session on "Probability" has also been arranged, to occur Wednesday at 10:00 A. M.

Arrangements have been made for mathematicians to be accommodated at the Commander Hotel and the Continental Hotel in Cambridge, not far from the grounds of Radcliffe College. The scientific meetings of the mathematical organizations will be in Longfellow Hall of Radcliffe College.

The Section on Physics (B) will meet in conjunction with the American Physical Society. The prominent item in their program will be a symposium on problems concerning the atomic nucleus. The American Association of Physics Teachers makes the keynote of the meeting "Demonstration Experiments," taking advantage of the facilities offered by Harvard and Tech. Professor George W. Pierce will give on Friday afternoon a popular lecture, abundantly illustrated, which will be of interest to others besides teachers in this field. The American Meteorological Society meets on December 27 and 28 and will feature preliminary results from the International Polar and Cloud Year observations.

The Section on Chemistry (C) has as its outstanding feature a joint session with the Section on Social and Economic Sciences (K), arranged as a symposium on "The Chemical Revolution." This symposium will deal with the economic significance of chemistry. Papers will be given concerning the repercussions of chemical changes upon international trade, the effects of chemical progress upon the relations between industries, the economic readjustments resulting from progress in chemical technology, and the possible future economic changes indicated by our present research progress.

The Section on Astronomy (D) will meet in joint session with the American Astronomical Society from December 27 to 29. The society plans to hold four sessions for contributed papers, namely, in the afternoon of the first day, both morning and afternoon of the second day and the morning of the third. Dr. and Mrs. Shapley will receive the society at the Harvard College Observatory after the first session.

The Section on Geology and Geography (E) plans to hold meetings for the reading of papers on Wednesday forenoon and afternoon, December 27. No special symposia nor joint sessions have been planned, inasmuch as the Geological Society of America and the Association of American Geographers are meeting in Chicago this year. It is expected that most of the papers on the program in Boston will relate to the geology of New England or adjacent portions of North America. If necessary, an additional session will be held on Thursday morning.

The Section on Zoological Sciences (F) will meet jointly with the American Society of Zoologists on December 28, 29 and 30. Thursday morning will be devoted to the reading of papers. In the afternoon a symposium will be held on "Development and Growth of the Nervous System," under the leadership of Dr. S. R. Detwiler. All day Friday will be devoted to events at the new Institute of Biology at Harvard University. Demonstrations and research exhibits by members of the Harvard staff are scheduled in the morning and in the afternoon, following the business meetings of Section F and of the Zoologists, the demonstration program of the society. On Saturday morning sessions for the reading of papers are scheduled, and in the afternoon the Zoologists will join with the Naturalists in a symposium arranged by the Naturalists.

The American Society of Parasitologists will hold its sessions on Thursday, Friday and Saturday. The exhibit and demonstration comes on Thursday afternoon. After the luncheon Friday noon and the business session immediately following it, the presidential address will be given by Dr. Wm. H. Taliaferro on "Some Cellular Bases for Immunological Processes in Parasitic Infections." A joint session with the Sec-

tion on Medical Sciences (N) will be held on Saturday.

The Entomological Society of America will meet on December 28 and 29. On the evening of December 28 there will be a joint meeting of the two entomological societies, at which time Dr. Frank E. Lutz, of the Museum of Natural History, New York City, will deliver the annual address of the Entomological Society of America. A symposium of interest to entomologists of all fields is planned for Thursday afternoon. The annual business meeting will be held on Friday afternoon. Entomological exhibits will be placed in a room near its session room.

The American Association of Economic Entomologists will begin its sessions on Wednesday and close on Saturday morning. It will hold a symposium on the subject of arsenical substitutes and spray residues. The public address will follow the dinner on Thursday evening.

The Section on Botanical Sciences (G) and its affiliated societies will meet on December 28, 29 and 30. A joint session with the Botanical Society of America, the American Phytopathological Society, the American Society of Plant Physiologists and the Mycological Society of America is planned for Thursday afternoon. The retiring vice-presidential address will be followed by a series of invitation papers. Professor M. L. Fernald, of Harvard University, will speak on some beginnings of specific differentiation in plants. Professor R. B. Thomson, of the University of Toronto, will present his ideas concerning the organization of the young vascular plant. Professor A. J. James, of Cornell University, will discuss modern view-points and tendencies in the morphology and classification of vascular plants.

The Botanical Society of America plans joint sessions as follows: (1) with Section G and affiliated societies, on Thursday afternoon; (2) with the Ecological Society of America on Friday afternoon; (3) with the American Society of Naturalists, Genetics Society of America and the American Society of Zoologists on Saturday afternoon. Meetings of the sections of the society will occupy the forenoons. The Systematic Section plans a symposium on the general subject of "New Approaches to Taxonomy" and includes trips to the Arnold Arboretum and Gray Herbarium in its program. The annual presidential address by G. J. Peirce, of Stanford University, will be presented after the dinner on Friday evening.

The American Society of Plant Physiologists will hold a joint session with the American Society for Horticultural Science on Friday morning. The society's business session is to be held in the afternoon of this day. At the annual dinner of the society on Thursday evening, a distinguished plant physiologist will be honored by a Charles Reid Barnes life membership. In the mornings and afternoons of December 28 and 30 papers will be read by members of the society.

The Mycological Society of America will hold a joint session with the American Phytopathological Society and another with Section G. The retiring president will address the society at its first regular session on Friday. Immediately afterward a short business session will be held. The other sessions will be given to the reading of mycological papers.

The American Phytopathological Society plans joint sessions as follows: (1) with Section G and other botanical societies on Thursday afternoon; (2) with the Mycological Society on Friday and (3) with the Potato Association of America on Saturday. On Thursday afternoon will be held the annual conference on extension work. Friday morning will be devoted to a report of the temporary committee on quarantines appointed at Chicago and a general discussion of the "Biological Basis of Plant Quarantines."

The societies related to the Sections on Zoological Sciences (F) and on Botanical Sciences (G) have announced attractive programs. The Ecological Society of America plans a joint session with the Botanical Society of America on Friday afternoon. On Saturday forenoon a symposium on "Oceanography," with Dr. T. Wayland Vaughan, Dr. S. A. Waksman, Dr. W. C. Allee and Dr. George L. Clark as the speakers, is listed. The annual dinner of the society will be held on Thursday evening, followed by the presidential address by Professor E. B. Powers, of the University of Tennessee. General sessions will be held on Thursday forenoon and afternoon and Saturday afternoon. Friday morning will be devoted to a business session.

The Genetics Society of America will hold regular sessions for the reading of papers on Thursday, Friday and Saturday mornings. Afternoons will be devoted to informal discussion and demonstrations at the new Biological Institute and to attendance at various symposia. An excursion is being planned to the Bussey Institution, in order that those interested may have an opportunity of seeing the work carried on there.

The American Society of Naturalists is again sponsoring the annual Biologists' Smoker on Thursday night. The annual symposium, a joint session with Sections F and G, including the Botanical Society of America, the American Society of Zoologists and the Genetics Society of America, will be held on Saturday afternoon; the topic is "Biology and Society." The program includes a celebration of the

semi-centennial anniversary of the society. The annual dinner of the Naturalists has been planned for Saturday evening, at which time the President, Dr. Burton E. Livingston, will deliver his retiring address.

The American Nature Study Society meets on December 27, 28 and 29. During the sessions the functions of the society will be discussed: "Fostering All Outdoor Activity," led by Professor George Green, of Pennsylvania State College; "Public School All Year Training," led by George Vinal, of Western Reserve University; "Elementary School Teacher Training in Science," led by Gerald Craig, of the Teachers College, Columbia University; "Research in Science Teaching," led by Florence Billig, of Detroit Teacher Training School; "Conservation," led by Stanley Mulaik, of Edinburg, Texas, and "Adult Education," led by A. F. Satterthwait, of the U. S. Entomological Bureau. The annual dinner will be followed as usual by an illustrated lecture. An exhibition illustrating the work of the various fields in which the society functions will be displayed in or near the session room.

The American Microscopical Society will hold its annual business meeting on Friday at 4 P. M.

The Section on Anthropology (H) is holding its meetings from December 28 to 30. No joint sessions have been planned. Thursday morning will be devoted to a discussion on "Anthropology as a Discipline." Friday morning will be given over to a symposium on "Anthropology and the Child," and the afternoon session to a discussion on "Anthropology and History." The Saturday morning session will center upon the consideration of "Anthropology and the Community."

The Section on Psychology (I) will meet from December 28 to 30. The sessions will be open for contributed papers.

The Section on Social and Economic Sciences (K) will meet on December 27, 28, 29 and 30. The Wednesday morning session will treat of the slum program. On Thursday morning a sociological session is planned, with the major paper by Professor P. A. Sorokin, of Harvard University. The joint session with the Section on Chemistry (C) on Thursday afternoon will be opened by a paper by Dean W. B. Donham, of the Harvard School of Business Administration, on "How Chemistry Has Altered Relations between the Industries." Later sessions will be devoted to joint sessions and reading of papers in accordance with plans not yet definitely adjusted. A joint session with Economics is set for Friday.

The Econometric Society will meet on Saturday with Section K. The morning program will deal with "Probability and Economics." Addresses will be given by Dr. Eugen Altshul, formerly chief of the Business Cycle Institute of Frankfurt, Germany; Mr. Victor von Szeliski, chief statistician for the National Recovery Administration, and Dr. C. F. Roos, principal economist of the National Recovery Administration. The afternoon program will be devoted to miscellaneous contributed papers.

The Section on Historical and Philological Sciences (L) will meet on December 27 and 28. On the first day will be presented the results of an intensive study of New England dialect conducted over a period of three years by the American Council of Learned Societies through a group of linguists, directed by Professor Hans Kurath, of Brown University.

The program will consist of a paper by Professor Kurath, who will describe some of the most interesting results that have been returned showing the geographical distribution of dialect characteristics. Professor Kurath's lecture will be illustrated by projections. It will be followed by the performance of a considerable number of phonographic records of dialect secured in different parts of New England and by a demonstration of the use of mechanical recording in securing language and music records in other parts of the country. There will, for example, be some records of Gullah dialect from South Carolina.

The study of New England dialect is part of the work on a general Linguistic Atlas of the United States and Canada, the preparation of which has been undertaken by the Council of Learned Societies.

On Thursday the topic will be "A National Policy for the Preservation of Historic Sites and Monuments." This session will be presided over by Dr. John C. Merriam, president of the Carnegie Institution of Washington. The principal paper will be presented by Dr. Verne E. Chatelain, chief of the Historical Division of the National Parks Service in Washington. Dr. Chatelain will state the general problem confronting the Historical Division, will illustrate by maps and pictures the distribution and nature of historic sites and monuments in the United States, and will outline a fundamental policy for their preservation.

The paper will be discussed by numerous scholars interested in the problem, particularly by those who have had experience in dealing with historic sites on a regional or state basis. The fact that the National Parks Service has recently become the custodian of the Military Parks, including such battlefields as Gettysburg, Vicksburg and Antietam, makes the discussion especially appropriate at this time.

The History of Science Society will meet on December 29. The program will be devoted to a review of scientific progress in the American colonies from 1621 to 1783. The president will give his re-

tiring address, reviewing the work of the society and its relation to the history of science movement. Dr. S. E. Morison, of Harvard University, will speak on the background of Colonial culture. Dr. C. A. Browne, of the U. S. Bureau of Chemistry, will have as a topic the history of industrial chemistry of the period. Dr. Lao G. Simons, of Hunter College, will speak on the mathematical knowledge in the Colonies. Dr. Henry R. Viets, of Boston, will speak on medicine in the Colonies. A number of other prominent speakers will also give papers, making thus a general symposium on Colonial culture.

The preliminary announcement of the Section on Engineering (M) will be a subject of special note to be published later.

The Section on Medical Sciences (N) will meet on December 27, 28, 29 and 30. On the first two days symposia on "Pneumonia," "Sociology and Medicine," "Tuberculosis," "Appendicitis" and "Typhoid Carriers" will be held. On December 29 there will be a joint meeting with the American College of Dentists. On December 30 the meeting will be given over to a joint session with the American Society of Parasitologists.

The Section on Agriculture (O) will hold a joint session with the American Society of Agronomy on December 28 under the auspices of the Northeastern Section of the Agronomy Society. The program has been arranged by Dr. T. E. Odland, Dr. M. H. Cubbon and Dr. M. F. Morgan, consisting of a symposium on "Field and Microchemical Methods for Determining Soil Deficiencies." Invitation papers will be presented by a number of men active in developing soil-testing technique.

The section will cooperate with Sections M and K in a symposium on "The Engineer and the Farm Problem" to be held on Saturday. The section will also meet in joint session with the American Society for Horticultural Science and the Agronomy Society on Saturday afternoon.

The American Society for Horticultural Science plans joint sessions with other organizations as follows: (1) with the American Society of Plant Physiologists on Friday morning, the program being devoted to physiological problems with horticultural plants; (2) with Section O at which the retiring president, Dr. J. H. Gourley, will be the principal speaker.

The Section on Education (Q) plans four sectional programs and a joint dinner with Section I. One of the Friday programs consists of a series of papers concerning recent investigations of the components of mental ability. Among others, Dr. E. L. Thorndike and Dr. Truman Kelley will participate. A second session on Friday will consist of reports of research from members of the section. One of the sessions on Saturday will be organized around the central theme, "The Measurement of Individual Growth or Progress," under the direction of Dr. Walter F. Dearborn. Another session will consider reports of research from members of the section.

The Gamma Alpha Graduate Scientific Fraternity will hold its annual council meeting for the consideration of fraternity business on Friday afternoon. On Saturday morning all members of the fraternity will meet for breakfast and informal reunion at the Statler Hotel.

Pi Gamma Mu will meet for the annual luncheon at the Hotel Statler at 12:30 P. M. on Saturday. National officers and several distinguished guests will speak.

Sigma Delta Epsilon plans to hold a business session open to members alone, and a breakfast open to all women in science, at which a guest speaker to be announced later will preside.

The program is unusually condensed, so that one finds an unfortunate number of conflicts. For this reason readjustments are being sought and if secured may change somewhat the arrangements outlined above. Those in charge of special programs are earnestly requested to send notice of any changes to the office of the permanent secretary at the earliest possible moment in order that the final program may be free from errors.

DEATH AS THE RESULT OF CHANGE OF LIVING MATTER WITHIN THE PLANT CELL[1]

By Dr. JEAN DUFRENOY

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LIVING is moving. Life implies perpetual change of form, perpetual interchange between the living matter and the inert surroundings. Movement, which we generally associate with life in animals, generally fails to be evident to us in the case of plants.

Still, much of the knowledge acquired during the recent years on the nature of living matter, and its

[1] Invitation address at A Century of Progress Meeting of the American Association for the Advancement of Science, Chicago, June 28, 1933.

changes, as conductive to death, has been acquired through the study of the plant cell.

The plant cells range in size from the enormous sap cells of the orange fruits, several millimeters long, to the ultramicroscopic viruses, for which the name Borellia was recently suggested, and which diameter probably is smaller than one fifth of one thousandth of one millimeter.

Some plant cells, therefore, afford a most valuable material to work out the general problems of life and death.

Inert as any plant cell may look because it is generally encased in rigid cell wall, still the living matter within responds to stimuli readily, and that response may often be much easier to study under the microscope than the response of the animal cell.

Besides, some plant organs actually respond to stimuli by movements which are quite evident, even for the casual observer; such, for instance, are the movements of the leaf of some insectivorous plants after they have captured an insect, or those of sensitive leaves that fold to a sleeping position. Our knowledge of these remarkable manifestations of cell life dates back to 1875, when Darwin, with a precision and accuracy at which we must really marvel, considering the optical equipment he had to depend on at that time, described what he termed "aggregation phenomena," and which deVries years later interpreted as to the part of the cell involved, which he named "vacuoles."

Active cells of the glandular hairs covering the leaves of a carnivorous plant like Drosera, or active cells of pulvinus causing the movements of sensitive leaves, contain many small drops of a highly viscous red liquid. To these drops, containing a watery solution of anthocyan, deVries gave the name of vacuoles. Our own observations confirm that the more active the cell is, the more numerous and the smaller these drops are within the cell; in other words, the more intensive the life of the cell, the more finely divided is the watery vacuolar solution, and, as a result, the greater are the surfaces of contact between those tiny water drops (or so-called vacuoles) with the surrounding living matter, or the so-called cytoplasm.

Whenever the manifestations of activity become less intense in the cell, these numerous small vacuoles aggregate together into fewer lobe-shaped vacuoles, which eventually round up.

Few among the plant cells contain those colored vacuoles, but all cells contain vacuoles as made up of drops of water containing substances in the solution, within the cytoplasm. In most of the living cells, vacuoles are colorless within the colorless cytoplasm so that their boundary only can be made out under the microscope or the ultramicroscope as a light-breaking line.

Another way to demonstrate vacuoles within the living cell is to make use of some water-soluble dyes which, when made into dilute solutions, can enter the living cell and penetrate through the cytoplasm without staining, to accumulate within the vacuolar solution, and concentrate therein to the extent of developing an intense color. This vital staining of the vacuoles can be obtained in a moment by immersing a section of living tissue or a piece of epidermis stripped off a leaf into a solution of neutral red, or cresyl blue, or phenosafranin or alpha naphthylamine, made isotonic and isoionic to the vacuolar sap by adding minute quantities of salts.

We could also stain vacuoles in actively growing cells by germinating seeds in nutrient solutions to which vital dyes had been added. The presence of vacuoles is absolutely necessary to the life of any cell, from bacteria up to the higher plants and animals.

Any stimulus enhancing the activity of the life processes within the cell always causes the one large vacuole, or the few large vacuoles of the cell, to break down into a network of smaller vacuoles, and eventually into a multitude of tiny drops.

This general phenomenon becomes of great significance in interpreting morphologically the intensity of the life processes, of which the rate of respiration is a fairly good measure. Any moderate stimulus, not resulting soon in the death of the cell, results both in that exaggeration of respiration which is commonly spoken of as "fever" and in the division of the vacuoles of the affected cell. That both phenomena should be linked is to be expected in the light of Warburg's and DeVaux's recent theories to the effect that the life process as expressed by the equilibrium of concomitant chemical reactions is manifest mainly along the surface of the living substance "cytoplasm" and more especially at the contact surface between the cytoplasm and enclosed watery "vacuoles."

That interphase along which respiratory and other fundamental cell activities take place may be represented as a polarized monomolecular film.

To a certain limit a cell is the more active as the cytoplasm is made more spongy by a greater number of small vacuoles, since the interfacial contacts between cytoplasm and vacuoles are larger, and as the circulation of the cytoplasmic material brings about frequent and noticeable changes into the repartition of the vacuolar material.

Most adverse conditions inhibit the building up processes while they enhance the disintegrating, oxidative processes.

Moderate excitations seem to enhance first, at least locally, the respiratory activity, resulting in fever.

Living cytoplasm and its fundamentally active inclusions, "mitochondria" and "plastids," are built of

a homogeneous complex of proteins and lipoids (fats).

Factors which slowly interfere with the normal life of the cell cause that complex to be split into its constituents, so that we find lipoids separating out into fat globules, and insoluble proteins disintegrating into water soluble fractions which go into the vacuolar solution, to be partially used up for cell metabolism or translocated to meristematic cells in growing points.

But while the living cell can draw freely on its reserves of starch and sugars, it can use up only a small fraction of its proteins. Some of the proteins in the plastids seem to be mobile, being replaced if nutritional conditions become better after periods of stress, but the bulk of the plastids themselves and, to all appearance, the whole of mitochondria are still demonstrable in starved cells and in cells badly affected by virus diseases. While the cell as a "reservoir" can be depleted of most of the substances stored in metabolic products by starving under aseptic conditions, we can write as our conclusion the same lines as Professor H. S. Reed wrote a quarter of a century ago as the conclusion of his researches on nutritional deficiencies: "No case was found in which the absence of an essential element caused serious modifications in the form or structure of the strictly living part of the cell"; the living cell is an architectural complex where life is possible as long as the fundamental constituents each retain a certain physical structure, while all keep some definite interrelations.

The study of life and death should make use of the microscope, through which we can learn much concerning the arrangement of the constituents within the living cell, and of the wrecking down of these arrangements when the cell dies.

But we feel that the highest magnification available with the microscope fails to reveal what is the fundamental difference between the living and dead cell, though the proper killing methods of modern cytology preserve the finest details of the cell arrangements, changing only the staining properties of the various cell constituents. Therefore we must look further into the essential structure of the cell substance, and the ultramicroscope, following the microscope, helps us a step further on.

The Structure of the Living Cell

When a living cell is examined on the dark field of the ultramicroscope, neither the cytoplasmic material nor that of any of the cytoplasmic inclusions (mitochondria or plasts) nor even the vacuolar solution within the vacuoles show any illuminated particle; therefore the living parts of the cell, although chemically complex, are physically as homogenous as perfectly clean water, being also "optically empty." What is illuminated by the dark-field illumination is the boundary of the cytoplasm, where it is in contact with any of its inclusions. Therefore, mitochondria, plastids or vacuoles are brightly outlined by the dark-field illumination, although their inside, like that of the cytoplasm itself, containing no particle to deflect the light, is invisible under the ultramicroscope.

Death is concomitant with the breaking up of that perfectly homogeneous living complex into a less fine material; death therefore is the change of ultramicroscopically invisible into ultramicroscopically visible. Of course, since the ultramicroscope is unable to make out any structure out of the living matter, the microscope is more hopeless still, and even under the highest magnifications, the living cytoplasm looks like a perfectly transparent material. As we can not stain the living matter, we only know of it through its carrying along microscopically visible mitochondria, plastids and fat globules, as cytoplasmic currents are flowing around the "vacuoles" in the cell.

While the cell is living, the cytoplasm can not be stained, but a number of stains, the so-called "vital stains," can penetrate through the cytoplasm to accumulate into the vacuolar contents, where they develop a deep color. Even when their vacuoles are heavily stained the cells may keep all the activities of living cells: They grow, they multiply. But, as soon as the cell dies, the vacuolar solution breaks down into a number of vacuolar precipitates, while the cytoplasm breaks down into a granular stainable material. Death therefore is the change of the microscopically structureless living substance into a material built of microscopically visible parts.

The only parts which we can stain within the living cell are: (1) The watery solution in the vacuoles which absorb the vital dyes; (2) the mitochondria which Janus green stains green and dahlia stains violet within the unstained cytoplasm; (3) the oil droplets, within the cytoplasm or within the plastids, which can be stained blue by nascent indophenol blue. But indophenol blue is so toxic that it should be spoken of as a post-vital dye rather than a true vital dye. Indophenol blue stains the oil droplets in the dead cell as well as it stains them in the living; whereas vital dyes stain the vacuolar solution as such only as long as the cell is living. As soon as the cell dies, the vacuolar solution within undergoes such changes as it no longer absorbs vital dyes, while those same dyes which penetrated the living cytoplasm without staining it readily stain the dead cytoplasm and nucleus. These changes are perhaps the best criteria of the death of the cell. Death, therefore, is the change of homogeneous vitally stainable vacuolar

material into granular vacuolar precipitates as well as the change of homogeneous unstainable cytoplasm into readily stainable gel.

Death is most conveniently diagnosed through the altered behavior of the vacuolar solution towards vital dyes. A living cell having been immersed in a weak solution of neutral red shows the vacuolar contents purple red within the unstained cytoplasm. A mechanical shock or the penetration of a poison killing the cell will result in the vacuoles immediately losing their red color, while the cytoplasm, nucleus and cell walls stain a dull, brick-red color.

The Effect of Hypotonic Solutions on Living Cells

Since Hugo deVries made known the osmotic properties of the living cell, we know that cell turgor results from the presence of the molecules of dissolved substances in the vacuolar sap. It is a well-known fact also that (except of course for water plants) when a living cell is immersed into tap water, the water from without tends to rush into the vacuole more quickly than the watery solution tends to flow out; not only is water taken in by the vacuolar sap, but also by some hygrophilous material (phosphatides) of the cytoplasmic inclusions, and especially so by mitochondria. As tap water penetrates into a plant cell, the mitochondria and eventually the plastids are seen to swell into spheres, the contour of which gradually fades.

That "vesiculization" of mitochondria and plastids is the commonest result of lethal effects which cause death of the cell within a few minutes.

As contrasted with the effect of plain water or of hypotonic solutions which are less concentrated than the solution within the cell vacuoles the effect of too concentrated (hypertonic) solutions is less likely to be rapidly fatal to the cell.

Poisoning Cells with "Vital Stains"

Vital stains are those which can be absorbed from dilute solutions by living cells to be stored into the vacuolar sap. Vital stains are more or less poisonous to the living cells so that any tissue may survive in a certain concentration of a certain vital stain, whereas a higher concentration will be more rapidly fatal.

Tobacco seedlings grow well under aseptic conditions in sterile nutrient media containing as much as 3 mg neutral red per liter. Higher concentrations result in the killing of meristematic cells at the root tip and in the inhibition of root growth, although the seedling, as a whole, survives.

It is therefore possible to poison certain cells within a tissue, without poisoning the bulk of the tissue.

It should even be possible to poison certain parts of a living cell without poisoning it whole, or at least it seems possible, through the effect of a proper concentration of vital stain, to obtain a local alteration of cytoplasm before the cell dies.

Sudden Death "Fixing the Cell" *vs.* Long Agony Altering Slowly the Cell to Death

Cells may die from a great many different causes, but the ultimate results in all cases are fundamentally alike: death is concomitant of the change from optically homogeneous living cytoplasm into a multitude of ultramicroscopic or even microscopic particles.

Sudden death only alters the ultramicroscopic structure of cytoplasm and of its inclusions, so that, as watched under the microscope, sudden death changes neither the general contour of cytoplasm (no shrinking) nor the shape of the nucleus, of the plastids, mitochondria or fat globules or of the vacuoles.

The staining reactions, however, are reverted so that the cytoplasm, which did not stain in the living, stains readily after death, while the vacuolar material, which absorbed readily vital dyes in the living, can no longer be stained as a whole after death (though, of course, the constituents, precipitated out of this vacuolar solution at death, can be microchemically detected by their specific reactions). Therefore, the picture of a cell stained after sudden death can be considered to be the negative of which the picture of vitally stained cell is the positive, and the photomicrograph of a cell stained by vital dyes could be superimposed to the photomicrograph of the same cell stained after sudden death (meaning a death such as is obtained by the killing mixtures which mitochondrial technique makes use of). On the contrary, great changes are noticeable in the picture of a cell which died of slow death, such as of a cell treated with fat solvents such as acetic acid or alcohol containing "killing fluids" or even more of a cell dying through the effect of imbibing water from dilute solutions or reversely of a cell dying from being deprived of water by bathing into concentrated salt solutions, and still more of a cell starved to death.

Local Death in the Cell

The living cytoplasm does not stain as such: it shows neither the staining reactions of lipoids nor those of proteins, although made up of a complex of both. Unmasking its lipoid and protein constituents is the result of the splitting of the cytoplasmic complex when the death process slowly advances. Such a disintegration generally is local and affects a certain area where the cytoplasm is honeycombed by a number of small vacuoles. As the lipoprotein complex breaks apart within the cytoplasm, water soluble

peptides go into the vacuolar solution, while lipoids are set free as fat droplets within the disintegrating cytoplasm, resulting in peculiar patterns which have been named "vacuolated bodies" when they were observed within cells affected by mosaic, but which resembled those in cells where proteolytic activity is locally enhanced as the result of parasitic action, or of starvation or malnutrition.

Excessive local proteolysis within the cell is made evident cytologically through the shredding of cytoplasm into a number of strands (where mitochondria and fat globules are particularly numerous), surrounding so many small vacuoles. The local exaggeration of surface contents between cytoplasm and vacuole must enhance the processes of oxidation.

It is a well-known fact that starvation, among other factors, results in excessive oxidation of affected cells, making available energy for the remobilization of materials to be translocated away towards meristematic tissues.

Differentiated cells indeed may endure starvation or malnutrition for a while, using up part of the lipoproteids from their plastids, and even part of the lipoproteid from at least a certain cytoplasmic territory, not only to provide for their own metabolism, but even to supply material to the meristematic cells of buds near by; meristematic cells indeed must be provided for, or they die; they grow and divide into more meristematic cells, building a perfectly normal structure by using the latest trace of available material, after which they abruptly collapse. Whereas the change of living matter into non-living should be studied primarily where sudden death does not permit of any premortal rearrangement of the cell material, still much can be learned from the study of the gradual disturbance of the cell metabolism, such as results from systemic infection or deficiency nutritional diseases.

Most valuable information was obtained from the study of the affection of citrus known as mottle leaf, which has been shown by Professor Reed never to cause necrosis, as it does not directly kill affected cells; those cells, however, may show a definite lagging in their evolution from bud time to leaf time. Affected leaves are generally yellow between the veins, along which some green color generally develops. Transverse or tangential sections through those yellow interveinal areas show that the palisade tissue, instead of being built of rows of narrow cylindrical cells, each with numerous large green plastids, is made up of a crowd of isodiametric cells, twice as wide as the normal, but none normally elongated. This inhibition of histological differentiation is concomitant with an inhibition of physiological differentiation: affected cells never develop any marked photosynthetic efficiency; this, in turn, is linked with inhibition of cytological differentiation, mitochondria being generally unable to differentiate into plastids.

Death of the Cell as Caused by Deficiency of One Essential Nutrient

Dr. Haas, at the department of physiology of the Citrus Experiment Station, Riverside, California, could grow successfully Citrus in liquid media: roots develop normally in Hoagland's complete solution, apical growth resulting from the normal activity of the three dome-shaped layers of initial cells at root tip.

When potassium is omitted, however, roots soon cease to elongate, since groups of meristematic cells collapse at the root tip; the death of these meristematic cells may release enough potassium to keep meristematic cells (located deeper inside the root tissue) proliferating, although they are unable to differentiate, so that the root tip, instead of elongating, by pushing the root-cap as it grows, swells into a club-shaped mass of small embryonic cells.

These cells keep dividing for a while, forming new living cells with a normal nucleus and normal mitochondria. Then, some marginal cells may show a tendency for mitochondria to clump together in a part of the cytoplasm which becomes more finely vacuolated. These mitochondria become shorter and thicker; their substance, as well as that of the cytoplasmic strands along which they line up, take stains more and more strongly after fixation, so that staining eventually demonstrates within the cell a certain vacuolated part of the cytoplasm as a deeply stained "vacuolated body" (which is homologous to the "vacuolated body" of many virus-affected cells). One whole cell soon collapses and dies. Alternative collapsing of embryonic cells, with subsequent renewal of growth following remobilization of material from dead cells, is specially evident in roots from solution where potassium is lacking but magnesium is available; some cortical cells towards the root tip get loose through pectinization of the middle lamella of their cell wall and eventually die, making material available for deeper meristematic cells to outgrow that degenerated section by budding out from its set of initials. In that case, the inhibition of apical growth is periodic, and results in a piling up of successive periods of activity separated by periods of degeneration, instead of the usual situation of development of lateral rootlets following inhibition of terminal growth. Starvation, or lack of any essential element, generally results in a bushy type of twig growth and excessive branching of roots; meristematic cells in bud and root tips die as soon as they have used up all the available food supply; their death releases the

material which they had been using for the building of the living substance: when remobilized material becomes available, lateral buds and initials of lateral rootlets start developing, soon to die at their tips, as the available food is used up. And as the whole of the used material can not be remobilized, the supply available for each successive beginning of development is less and less, so that the successive lateral buds develop into shorter and shorter shoots, bearing smaller and smaller leaves, before they die.

But while the shoots or leaves may be dwarfed, the constitution of each embryonic cell within is normal as long as, food being available, they survive, after which they abruptly die.

Cytology of Starved Cells

Each physiological process in the cell is concomitant with an antagonist process: At the same time when a synthetic process builds up complex molecules, a reverse analytic process disintegrates complex molecules into simpler, translocable constituents.

Each process may be especially enhanced by exciting or slowed down by inhibitory agents, but, on the whole, analytic processes keep on going under conditions which prove adverse to synthetic processes.

While chloroplastids build starch out of the CO_2 from the atmosphere when receiving proper illumination, starch is being hydrolyzed into sugar. Under normal conditions the building of starch (amylogenese) is the faster process during the day. Amylolysis is the faster process during the night.

But starch is dependent on many factors besides light and CO_2. Lacking some of the necessary conditions, the plants build starch no more, while starch previously formed disappears as it is being hydrolyzed into soluble glucids to be used up by other cells.

Under normal conditions starch grains may dwindle during the night from the plastid from which they are being translocated.

In starved cells, starch grains seem to be slowly hydrolyzed from the periphery inwards, so that the central part of each grain may give the color reaction of starch when treated by the solution of iodine and potassium iodide, while the periphery of the grain gives a very faint or no color reaction, so that the stained central part of each starch grain is surrounded by a clear unstained halo. As this hydrolysis proceeds, the plastid seems to be hollowed out, and assumes a sieve-like appearance. At the same time, the lipoproteidic material (of which the plastid itself is normally built) may swell and disintegrate into its two main constituents; lipids and proteins. In fact, a starved cell draws on the plastids' material when proteins have to be remobilized within the cell. Proteins are primarily obtained through the disintegration of the lipoproteidic complexes of which the plastid is made up. As these lipoproteidic complexes disintegrate, water-soluble peptides are made available, and these go into solution in the vacuolar sap or move out of the cell, while the fatty part of the complex separates out in the form of so many fat droplets within the plastid. Moderate translocation of proteins leaves the plastid able to make up for that loss whenever conditions become favorable again. But if the disintegration proceeds too far, the plastid is irremediably impaired and "dead" to the cell for all purposes. Next to the lipoproteins in the plastid the cytoplasm depends on the lipoproteins which build up its own living substance: as starving is more severe, part of the cytoplasm itself disintegrates into proteins and fat globules. Not all of the proteins, however, seem to be available for new constructive processes. Part of it crystallizes out into cubic proteidic crystals in the very place where disintegration processes occur. Not only do certain cells in a tissue undergo a severe disintegrating process to make nutrients available to neighboring cells, but in one given cell, part of the cytoplasm may disintegrate, while the remaining parts of the cytoplasm keep living.

Disintegrating parts of starving cells are easily made out under the microscope because of the spongy appearance of involved cytoplasm, because of its higher refractory power as well as because it shows numerous fat globules and proteid crystals. After the cell has been properly fixed by cytological methods the disintegrated part of the cytoplasm can be made out because it stains more deeply with most stains, and because it shows the microchemical reaction for proteins.

Starving a Plant Cell to Death

Cells of reserve tissues or cells from aged leaves, roots or twigs are normally deprived of some of their reserves for the benefit of meristematic tissues, as the plant grows. Senile cells, from which carbohydrates, proteins and even minerals have been translocated away, are easily infected by microorganisms and can hardly be expected to survive long under ordinary conditions. Therefore, we have been studying the impoverished cells of seedlings grown in sterile media, under aseptic conditions, when no microorganism could interfere with the long agony brought about through the only effect of starvation. Under these conditions the discriminating line between life and death may become more difficult than ever to draw, as some differentiated cells survive gradual depletion, for months or even years, while meristematic cells collapse in a very short time.

In any cell that dies slowly, the plastids are the

first part to be evidently affected. They are the reservoir which the cell draws upon for carbohydrates and proteids. Depleted plastids have a tendency to agglutinate as the neighboring cytoplasm assumes the structure of a network around a number of small vacuoles, which contents become richer in water soluble peptides, as first the plastids, and then the cytoplasm itself, undergo proteolysis.

Death may abruptly affect the cell as a whole, "fixing" the various cell constituents in the place they occupied at the moment death occurred; or death may affect the cell slowly during which agony the constituents have time to undergo changes. Premortal changes are fundamentally alike, whatever the cause of death: their results mainly depend on how long the cell endured.

Lethal factors which act very slowly (malnutrition of adult cells, infection by endophytes or viruses), will first produce increased respiration in the affected cell when part at least of the cytoplasm will become spongy. Proteolytic processes, being enhanced, result in the formation of more water soluble peptides which may accumulate in the vacuolar sap. Finally, large vacuoles are partitioned off into a number of smaller ones by the extension and branching of cytoplasmic strands.

CONCLUSION

Death is the change from the clearly visible harmonious arrangement of homogeneous living parts of the cell into crowding of microscopically heterogeneous material.

The living cell is a harmonious building, coordinating a number of homogeneous materials, the contour of which can be made out under the microscope or the ultramicroscope, making the architectural design of the living cell observable. Killing the cell suddenly by proper cytological technique preserves the architectural disposition of the cell materials, making those materials themselves visible through ultramicroscopical changes of structure admitting of staining. Slow death of the cell preserves neither the architectural disposition of the cell material nor even its microscopical structure, as premortal changes are mainly concerned in the splitting of the homogeneous unstainable living complex into a coarse, granular collection of its constituents.

SCIENTIFIC EVENTS

REFORESTATION BY THE TENNESSEE VALLEY AUTHORITY

TEN thousand bushels of pine cones and other seeds are being harvested by the members of the Civilian Conservation Corps for use in reforestation work in the Tennessee Valley, according to an announcement made by Robert Fechner, director of emergency conservation work. The seeds are being gathered largely in Virginia, West Virginia, North Carolina and Arkansas. The program calls for planting the seeds in nurseries this winter. Later the seedlings will be transplanted in the areas to be reforested by the Tennessee Valley Authority.

Five thousand members of the Civilian Conservation Corps have been assigned to Tennessee Valley work by Director Fechner. These men will be distributed among twenty camps in Tennessee and five in Alabama. One of the major tasks assigned will be that of combatting soil erosion through tree planting, this being part of a general erosion control program to be carried on in the central, southern and western states.

To obtain the amount of seed necessary for the reforestation of the valley, the collection has been apportioned among the four national forests in the states specified on a quota basis. The total harvest will include 600 bushels of yellow poplar seed pods, 4,000 bushels of short-leaf pine, 2,600 bushels of Virginia pine, 2,900 bushels of black locust pods, all capable, under proper care, of producing 2,000,000 yellow poplar, 10,000,000 short-leaf, 8,000,000 Virginia pine and 6,000,000 black locust tree seedlings. Pitch pine cones, of which there is a limited supply in the forests of this region, will be collected in lots of 25 bushels or more.

As soon as the ripe cones are picked, they are shipped to the three southern nurseries of the U. S. Forest Service for drying and seed extraction. These nurseries are at Parsons, West Virginia; Russellville, Arkansas, and Catahoula, Louisiana, which is a new federal nursery. The prepared seeds are forwarded to the Tennessee Valley Authority and probably will be planted in two new nurseries which that organization is planning to establish in the Tennessee Valley.

Although it is often easier to pick cones from trees felled in lumbering operations, most of this year's collections will have to be picked from standing timber. Where it is necessary to climb high trees or ladders the Forest Service has ordered that safety belts be supplied. State and private land camps in the vicinity of the national forests are to be enlisted with those on the national forests during the harvest.

AN AMERICAN DECIMAL-METRIC CODE

PROPOSING that the United States shall make general use of metric weights and measures, an American Decimal-Metric Code has been drafted and urged for adoption, to assist the administration in effecting eco-

nomic and educational improvement under the National Recovery Act. Strong support is expected to be given the proposal by government experts, many of whom have been outspoken for the world-uniform standards. While not sponsoring any specific proposal, President Franklin D. Roosevelt has declared, "I have always favored adoption of the metric system by this nation."

The purpose of the Decimal-Metric Code is "to establish a single standard for the expression of all values, measures, weights, angles, temperatures, etc., which is best adapted for American national and international service." The author of the code, Captain Manly B. Gibson, of Fort Banks, Massachusetts, states that while it is offered primarily in the interest of American school children, its benefits will be shared by practically every man, woman and child in the United States. The code will reduce the time and labor now required for training in elementary mathematics and practical measurements in public schools by approximately fifty per cent. To young Americans and to future generations the code will, it is said, save billions of hours of child-labor now wasted on an unsatisfactory and inefficient educational program.

With the adoption of this code, all civilized nations of economic importance, except Great Britain, will use decimal-metric units. It will give increased efficiency in every phase of American endeavor, with an economy of more than two billion dollars annually. Using this universal single standard for the expression of values, weights and measures, American advertising will find a new and more favorable domestic and foreign market for American products.

Not only is a metric code being urged for adoption under the NRA, but metric advocates throughout the United States are launching a movement to secure liberal legislation in the new session of the Congress providing for general adoption of metric weights and measures. Metric petitions are being sent to the chairman of the Committee on Coinage, Weights and Measures, U. S. House of Representatives, Washington, D. C.

ACTIVITIES OF THE U. S. WEATHER BUREAU

CURTAILMENT in most of its activities characterized the program of the Weather Bureau, U. S. Department of Agriculture, for the fiscal year ending June 30, according to the annual report made public on November 22. In spite of substantial retrenchments, however, normal functions were continued and a new plan for increasing the number of ship's reports during the tropical hurricane season was put into effect.

The bureau also took an active part in the International Polar Year, which began August 1, 1932, and ended August 31, 1933. Special observations were made at a station established for the purpose at Point Barrow, Alaska. The results of these observations, together with observations by all the other meteorological services of the world, will serve as the basis for detailed weather maps on a world-wide scale, from which, it is hoped, valuable aids to forecasting may be developed.

To effect the necessary economies, more than 20 first-order stations were closed, the service at others was cut, and nearly 500 employees were dismissed. In addition, 30 storm-warning, 11 second-order, 5 tobacco, 46 cattle-region, 97 crop-weather, 84 river and rainfall and 7 snowfall stations were closed. The number of places to which daily forecasts are telegraphed was reduced by more than 125, and the distribution of coded telegraph reports was cut drastically. In other cases the issuing of weather maps was either suspended or replaced by card bulletins.

Service to the public, to agriculture and to the industries, carried on as usual, cover the following lines of activity:

About 200 first-order stations, spread over continental United States and the possessions, except the Philippines, provide twice-a-day telegraphic reports and other observations, reports and automatic records, which form the basis of all the bureau's public service. General weather forecasts are issued twice each day for all states, parts of states and larger cities. The stages of the principal rivers are gaged and reports, on which the flood-warning service is based, are prepared.

From June to November hurricane warnings are issued for the benefit of all shipping plying the adjacent oceans, the Gulf of Mexico, the Caribbean Sea and the Great Lakes. More than 1,200 secondary stations, not including any airway stations, furnish simple reports of rainfall, river, weather and crop conditions.

A network of cooperative observers, using government equipment, but serving without compensation, send in daily reports on the temperature, rainfall and state of the weather. Incidental to the daily and weekly reports from 200 first-order and 300 secondary stations, the bureau issues a weekly bulletin of weather and crop conditions. A frost and cold-wave service for the benefit of citrus growers is maintained in Florida, Mississippi, Texas, California, Oregon and Washington. Warnings of temperature and cold waves are issued for shippers of perishable products and livestock and for use in the care and protection of livestock on the range in winter and at shearing time in the spring.

Solar radiation at the earth's surface, the ultimate source of all terrestrial weather and life, is investigated and measured. In accordance with the air commerce act of 1926, the bureau furnishes "such weather reports, forecasts, warnings and advices as may be required to promote the safety and efficiency of air navigation in the United States and above the high seas."

THE LEON MANDEL GUATEMALA EXPEDITION OF THE FIELD MUSEUM

A ZOOLOGICAL expedition, sponsored by Leon Mandel, of Chicago, to make extensive collections of birds, mammals, reptiles and amphibians of Guatemala for the Field Museum of Natural History, sailed from New Orleans on November 22, aboard the steamship *Tivives* for Puerto Barrios.

A few weeks hence, after preliminary reconnoitering has been completed and definite camps established, Mr. Mandel is expected to join the expedition for a few weeks' vacation. This is the second expedition in which he has personally participated as a collector. In 1932 he organized and led the Mandel-Field Museum Zoological Expedition to Venezuela which was conducted aboard his yacht *Buccaneer,* making a long sea voyage and penetrating the innermost navigable reaches of the Orinoco River.

Karl P. Schmidt, assistant curator in charge of reptiles at the museum, is leader of the party. He is accompanied by F. J. W. Schmidt, biologist; Emmet R. Blake, ornithologist, and Daniel Clark, general assistant. The expedition will remain in Guatemala for about six months, surveying various regions of the country, which is remarkable for its diversification of climate and altitude. This diversity of habitat, which results in a wealth of species of animal life, reaches its maximum for Central America in Guatemala. The country is of special interest zoologically also because it is the meeting ground of North and South American types of life.

The Field Museum has for years carried on an extensive program of investigation of the fauna of the American tropics, and the present expedition is for the purpose of furthering these studies. While the expedition's primary aim will be to collect specimens for addition to the museum's scientific reference collections, it will also seek material for exhibits, including species of tropical reptiles, and of Central American birds to be used in a series of groups reproducing their natural habitats.

Leader Karl Schmidt will concentrate his efforts on reptiles, while his brother, F. J. W. Schmidt, will specialize on mammals and Mr. Blake will have charge of bird collecting. Karl Schmidt's share in this expedition will be a continuation of his work on the Central American fauna for which he was awarded a fellowship in 1932 by the John Simon Guggenheim Memorial Foundation. As far back as 1923 Mr. Schmidt made extensive collections in the adjacent countries of Honduras and British Honduras. Among the most interesting creatures to be collected on the present Guatemalan trip are arboreal salamanders and frogs, many of which have extraordinary breeding habits. F. J. W. Schmidt has for several years experimented with special methods of collecting mammals, and will apply his experiences on the exceptionally rich mammalian fauna of Guatemala in the hope of collecting new and little-known forms. Mr. Blake was one of the principal collectors on the Mandel-Field Museum Zoological Expedition to Venezuela in 1932, on which he collected and prepared more than 800 birdskins within a period of five weeks in the mountain rain forests of the Mount Turumiquiri region.

ESTABLISHMENT OF THE MARTIN GUSTAV AND CAROLINE RUNICE HANSON FUND AT THE SMITHSONIAN INSTITUTION

THE September, 1933, number of *Minnesota Medicine,* page 589, gives an account of the presentation of a gold plaque to Dr. Adolph M. Hanson, of Faribault, Minnesota, by the State Medical Association "in recognition of his discovery and isolation of the parathyroid hormone and in grateful appreciation of the distinction thus conferred upon the medical profession of Minnesota." This recognition in his home community happens to coincide with the granting, after an extensive interference proceeding in the course of which four other claimants were eliminated, of basic U. S. patent No. 1,890,851 to Dr. Hanson for an "Extract of the Parathyroid Gland and Process of Preparing Same."

An interesting story lies behind this scientific achievement.

When Dr. Hanson returned from the war in 1919,[1] he left behind him an enviable record of work in neurosurgery done under the stress and strain of the battlefield; naturally he sought something to divert his mind from reliving the experiences he had just gone through. Although engaged in the practise of medicine, he decided to work toward his master's degree at a near-by college, and chose the parathyroid gland as his subject of study since comparatively little was known about it at that time. He rigged up a small laboratory in his basement and obtained permission from the college to do the necessary laboratory work there in his spare time.

After a preliminary chemical study of the gland he identified xanthine as the predominating purine body by following the standard procedure of boiling the gland in dilute sulfuric acid. He then tried boiling it in dilute hydrochloric acid to see if xanthine could be isolated in the same way, but to his surprise the solution behaved quite differently. He was led to suspect that some substance peculiar to the parathyroid glands could be isolated in larger amounts with hydrochloric acid than with sulfuric acid. This, together with the knowledge that hydrochloric acid was sometimes injected to relieve tetany in dogs, suggested the possibility that hydrochloric acid

[1] Dr. Hanson contributed the chapter on "Management of Gunshot Wounds of the Head and Spine in Forward Hospitals, A. E. F.," to "The History of the Medical Department of the U. S. Army in the World War," edited and published by the Surgeon-General of the U. S. Army.

might have some selective activity on the parathyroid. He called his solution Hydrochloric X and described it in the *Military Surgeon* for April, 1923. The article attracted little attention partly because endocrine workers did not regularly review the *Military Surgeon* for articles in their field and partly because they doubted the advisability of boiling a gland with a mineral acid in order to extract an active principle! Nevertheless, Hanson arranged to have his Hydrochloric X tested on parathyroidectomized dogs and was gratified with the result. He was convinced that he had hit upon a method of releasing the substance in the parathyroid gland that was responsible for raising blood calcium and relieving tetany in dogs. He published his results in the *Military Surgeon* for January, 1924. They were soon ably confirmed and extended by Collip (1924).

It is now learned that Dr. Hanson, immediately after having been awarded his patent, assigned to the Smithsonian Institution at Washington all income and royalties accruing to him. The grant has been accepted by Dr. C. G. Abbot on behalf of the institution and will be known as the Martin Gustav and Caroline Runice Hanson Fund, thus assuring that all income will be used in the furtherance of science. Three of the largest pharmaceutical houses in the country are already operating under the patent, namely Parke, Davis and Company, Eli Lilly and Company and E. R. Squibb and Sons.

The spirit which motivated Dr. Hanson through all the years when he worked alone on his problem, sacrificing his resources with the disregard of one truly unselfish, is well illustrated by his final act in the interests of science.—OLIVER KAMM.

AWARD OF THE COMSTOCK PRIZE OF THE NATIONAL ACADEMY OF SCIENCES TO PROFESSOR BRIDGMAN

THE Comstock Prize of the value of $2,500 was presented to Dr. Percy W. Bridgman, Hollis professor of mathematics and philosophy at Harvard University, at the dinner of the National Academy of Sciences held at Lowell House, Harvard University, on the evening of November 21. The report of the chairman of the Comstock Fund Committee, Dr. Max Mason, president of the Rockefeller Foundation, was made by Dr. Fred E. Wright, home secretary, and the presentation was made by Dr. W. W. Campbell, president of the academy. The report of the committee was as follows:

In awarding the Comstock Prize for the five-year period ending in the present year, the National Academy of Sciences recognizes the brilliant achievements of Percy Williams Bridgman in advancing our knowledge of the behavior of matter. Bridgman is both an experimenter and a theorist. Working indefatigably in a field of great experimental difficulty, he has derived an enormous array of fundamental facts, while new insights and physical concepts have come from the keen analysis of his theoretical studies.

Most of Bridgman's work falls into three categories: the first, so peculiarly his own, the behavior of materials under high pressure; second, the properties of single crystals at normal pressures; and, third, the application of thermodynamics to electrical phenomena.

To catalogue the phenomena and the material studied under the difficult technique of high pressures, and, of recent years, low temperatures as well, gives a picture of the astonishing extent of Bridgman's work. He has studied compressibilities, melting points, polymorphic transitions, electrical resistance, thermo-electric behavior, thermal conduction and viscosity. An idea of the amount of material gained through these difficult studies may be obtained from the fact that compressibilities have been measured for 80 solid compounds, 54 elements, 60 liquids, as well as several gases. To state very briefly some of the general results obtained, it has become clear that most of the compression of substances at high pressure is provided by the compression of the atoms and molecules themselves, and not by diminishing the space between them; that previous ideas on the course of the melting curve must be modified since, for example, there is no critical point, but melting temperature may rise with pressure until the atoms break. Theories of the solid state must reckon with Bridgman's result on polymorphic transitions. Why, for example, should rubidium chloride be forced by high pressure from a face-centered to a body-centered cubic arrangement when calcium chloride is not so affected? Many anomalies are shown in Bridgman's studies of electrical resistance under pressure. In 1930 a result of outstanding and fundamental significance was obtained. Working at enormous pressure and at low temperature, Bridgman determined that a temperature of minimum resistance exists for the alkalies. Lowering the temperature beyond this point increases instead of lowers the resistance. This result, of far-reaching importance, must be a guide for all theories of electrical conductivity.

A large series of determinations of the behavior of single crystals has resulted from Bridgman's development of an easy way of forming single crystals of metals and salts. In recent years he has determined for many such crystals the elastic constants, electrical resistance, thermal conductivity and thermo-electric effects.

In a series of articles Bridgman has applied thermodynamic analysis to electrical phenomena, with results of far-reaching importance. It was thus discovered and experimentally demonstrated that an internal Peltier heat in crystals exists where the direction of current flow changes. This means that the direction of motion of an electron in a metal can not be changed without the expenditure of a definite amount of energy, the result again furnishing a fundamental fact which must be reckoned with in electron theory. Through application of thermodynamics to the transverse galvano-magnetic effects Bridgman has shown the existence of a new physical concept, a thermo-motive force, by virtue of which under proper conditions temperature differences may exist within a material without heat flow. Bridgman

has established by further thermodynamic arguments the existence of several new effects, among them a new kind of electro-motive force in a circuit carrying a current in which the temperature is changing.

In addition to his many contributions to the form and substance of his own special branch, Bridgman has served the broad field of science in a most significant way. His writings on the logical and philosophical foundations of science have given sensible and suggestive answers to many fundamental questions. His development of the idea of operational concepts has clearly played an important rôle in the most recent physical theories. It has been an unusual and gratifying experience to read, from his pen, scientific philosophy that is both philosophical and scientific. Such contributions could perhaps be made only by that rare person who is at the same time a gifted experimenter, an able theorist and a sensible man.

Professor Bridgman, in accepting the award, expressed his great appreciation of the high honor done him by the academy and the Comstock Committee. It was a particular pleasure that the chairman of the committee was Dr. Mason, with whom he had been closely associated in experimental work for the government during the war. He continued:

Dr. Mason has given some idea of the nature of the work already accomplished; it is of interest to indicate what in addition may be expected in the future. With regard to work under high pressure, it appears that there is an enormous amount of fine scale irregularity in the relation between pressure and volume of a number of solid substances, which may perhaps depend on a complicated interchange of electrons between the atoms. Quantum theory is just beginning to be able to handle this sort of thing, and a wealth of new experimental data may be expected to clarify our understanding of the nature of the fundamental processes. Further, there are a number of questions connected with the electrical resistance of conductors which involve measurements under pressures higher than those yet used, and these experiments are now being started.

Most of the work has been in a field not fashionable at present. This field is to be broadly characterized as concerned with the properties of matter in bulk, as opposed to the properties of matter on a small scale, atoms and electrons, with which most physicists are at present occupied. It is entirely proper that activities should be mostly concerned with a study of the submicroscopic elements of the physical world, for here are the most interesting problems, and it is here that the deepest insights are to be obtained. But the study of large-scale phenomena is also important, and it is justifiable that at least a few physicists should be occupied with it. There are two very broad purposes which may be furthered by a study of large-scale phenomena, which in principle can not be obtained from small-scale phenomena. In the first place, modern theoretical physics seems committed to the thesis that all large-scale phenomena can be completely understood in terms of the properties of the small-scale elements. A justification for this can be only empirical, and that justification has not yet been given by any means. It is entirely conceivable that large-scale matter might embody properties which the biologists would call "emergent," which can not be predicted from even an exhaustive knowledge of the properties of the isolated elements. We can never be sure of the thesis that there are no "emergent" properties until the explanation of large-scale properties is completely worked out, and for this reason it is important that our knowledge of large-scale properties be as wide as possible. In the second place, the concepts in terms of which we describe small-scale experience are themselves derived from large-scale experience, and it is therefore vital that the concepts be adequate to describe large-scale experience. These concepts were a slow growth and the result of long rumination, continual fitting and adjustment, to insure that the evolving concepts completely corresponded to all the known experimental facts. The later generations forget this slow process of growth, and accept the concepts as they find them. But the discovery of new experimental facts beyond the range of those known when the concept was crystallized should demand the reexamination of the concept to determine whether it is still adequate. Only by being everlastingly self-conscious of the experimental basis of our concepts and the possibility of necessary revision as knowledge of large-scale phenomena broadens, can we be sure that the basis for our theoretical speculations remains sound.

SCIENTIFIC NOTES AND NEWS

RESPONDING to protests against the enforced retirement of Dr. William H. Park from the New York City Health Department, Mayor O'Brien wrote recently to Dr. Park assuring him that he would be continued in service after he reached the retirement age of seventy years on December 30.

THE John Scott Medal of the City of Philadelphia has been awarded to Dr. Frank Conrad, engineer of the Westinghouse Electric and Manufacturing Company, for his research work on radio broadcasting.

THE American Association of State Highway Officials, the American Road Builders' Association and the Highway Research Board of the National Research Council announce the conferring of the George S. Bartlett Award on James H. MacDonald, formerly state highway commissioner of Connecticut and for many years treasurer of the American Road Builders' Association. The presentation will be made at the annual meeting of the Highway Research Board on December 7. Mr. MacDonald was chairman of the original State Highway Commission of Con-

necticut, which was authorized by the Legislature in 1895. On August 30, pursuant to an act of the State Legislature of Connecticut, a tablet commemorating his many years of service was unveiled at a site on Avon Mountain by Governor Wilbur L. Cross. Previous recipients of the award are: In 1931, Thomas H. MacDonald, chief, U. S. Bureau of Public Roads, and in 1932, Arthur N. Johnson, dean of engineering, University of Maryland. The award is in the form of a bronze plaque bearing a likeness of Mr. Bartlett with the words: "George S. Bartlett Award for Outstanding Contribution to Highway Progress."

PROFESSOR CHARLES A. ELLWOOD, head of the department of sociology at Duke University, was elected on October 20 in Geneva president of the International Institute of Sociology for the year 1935–36. Professor P. A. Sorokin, head of the department of sociology at Harvard University, was at the same time elected a vice-president. The institute is made up of two hundred leading sociologists of the world as members, with two hundred associates.

BYRON E. COHN, assistant professor of physics at the University of Denver, has received from the Van't Hoff Foundation a grant of 250 guilders (approximately $100), which he is to use in his study of luminescence.

THE Committee on Scientific Research of the American Medical Association has made a grant to Dr. S. S. Lichtman, of New York City, for the investigation of a new method for the estimation of bile salts in body fluids. The work will be carried out in the laboratories of the Mount Sinai Hospital, New York.

DR. JOHN BEATTIE, associate professor of anatomy in McGill University, has been appointed conservator of the museum and director of research of the Royal College of Surgeons, London, in succession to Sir Arthur Keith.

JOHN D. COFFMAN has been appointed chief forester of the newly established branch of forestry in the Office of National Parks, Buildings and Reservations in the Department of the Interior. For the past five years Mr. Coffman has been fire control expert of the National Park Service, with headquarters in Berkeley, California. For nineteen years previous to that he was a member of the U. S. Forest Service, the last twelve years of that time serving as supervisor of the California National Forest, now named the Mendocino National Forest. Mr. Coffman has been in Washington since early last April, assisting the former director Horace M. Albright and later director Arno B. Cammerer in the administration of the emergency conservation program in the national parks and monuments from the beginning of that program.

THE appointment of Henry W. Nichols as acting curator of the department of geology at the Field Museum of Natural History has been announced. Mr. Nichols was long associated with the late Dr. Oliver C. Farrington, curator of geology, who died on November 2. Mr. Nichols joined the museum staff in 1894, and during the early years of the institution served as curator of economic geology. Later, when the various divisions were consolidated into a single department of geology, he remained as associate curator. He has participated in and led a number of the museum's expeditions. In his most important field work he covered the greater part of South America collecting geological material.

RICHARD KILBOURNE, forester for the Extension Service of the University of Maryland during the last three years, has resigned to become assistant chief of planting in the forestry department of the Tennessee Valley Authority at Knoxville.

PAUL J. DAUGHENBAUGH, of the chemical research staff of the Graduate School of Yale University, has accepted a position as research chemist in the chemical research department of the Sharp and Dohme Laboratories, Philadelphia.

DR. DAVID WEEKS, associate professor of agricultural economics in the University of California and founder of the California Economic Research Council, again has been elected to the chairmanship of the organization for the ensuing year. Associated with him in the management of the program for this year are Dr. Carl Alsberg, Stanford University, and Herbert F. Ormsby, California State Chamber of Commerce, as vice-chairman and secretary, respectively. The council is setting up machinery to aid the Central Statistical Board in coordinating economic statistical data of value to economic planning.

THIRTEEN fellowships in medicine, including two renewals, for study in the United States and Europe during 1933–1934, were awarded at the fall meeting of the Medical Fellowship Board of the National Research Council, Washington, D. C., of which Dr. G. Carl Huber, dean of the Graduate School at the University of Michigan, is chairman. A list of the successful candidates follows: John A. Calhoun, Louis H. Cohen, Knox H. Finley, Smith Freeman, Champ Lyons, Edward J. G. McGrath, Carl V. Moore, Edgar J. Poth (renewal), Boris B. Rubenstein, Albert B. Sabin, Robert D. Stiehler, William Trager and Julius White (renewal). The spring meeting of the Medical Fellowship Board will be held in March, 1934, and applications to be considered at that time should be filed on or before February 1.

THE congregation of the University of Oxford has decreed to pay to Professor Arthur Thomson an annuity of £800 on his retirement from Dr. Lee's pro-

fessorship of anatomy. A. H. Smith, fellow of New College, in proposing the decree, said it related to a professor under the old statutes and in whose case, when he retired, it was necessary to provide a pension, since he did not come under the superannuation scheme. The object of the decree was to ensure that, when the time of Professor Thomson's retirement arrived, he should not be hampered by lack of adequate provision for a pension.

JASON R. SWALLEN, assistant agrostologist in the Bureau of Plant Industry, sailed on November 22 for Pará, Brazil. He will spend six months collecting and studying grasses in the states of Pará, Maranhão, Piauhy, Ceara and Rio Grande do Norte.

DR. I. A. GALLOWAY, from the Hall Institute of Research in Pathology, Sydney, Australia, is visiting the United States.

DR. ERICH WASMUND, professor of geology at the University of Kiel, has been studying the equipment and methods of the Scripps Institution of the University of California. Dr. Wasmund is about to organize at Kiel, on the shores of the Baltic Sea, connected with the North Sea by the Kiel Canal, the first oceanographic institution in Germany at which are carried on all lines of oceanographic study, such as marine biology, chemistry, physical hydrography and geology.

DR. WILLIAM WALLACE CAMPBELL, president of the National Academy of Sciences, president emeritus of the University of California and director emeritus of the Lick Observatory, was the principal speaker at the annual Carnegie Day exercises of the Carnegie Institute of Technology on November 28.

DR. ROSCOE WILFRED THATCHER, formerly president of the Massachusetts State College, Amherst, and since 1933 research professor of agricultural chemistry, was a guest lecturer at the University of Missouri on November 17. He spoke on a proposed classification of the chemical elements with respect to their functions in the nutrition of plants.

F. TRUBEE DAVISON, president of the American Museum of Natural History, will give a lecture at the museum on December 5, at 8:15 P. M., on "Collecting in Africa for the Akeley Memorial Hall."

PROFESSOR GEORGE GRANT MACCURDY, of Yale University, director of the American School of Prehistoric Research, lectured before the Brown University Chapter of Sigma Xi on November 28, his subject being "Progress in Prehistoric Research."

AT its meeting on November 23, the Geological Society of Chicago was addressed by Dr. W. H. Collins, director of the Canadian Geological Survey, on "The Behavior of Some Basic Magmas."

THE ninth annual Norman Lockyer Lecture, established by the British Science Guild as a means of periodically directing the attention of the public to the influence of science upon human progress, was given on November 23 by Professor E. V. Appleton, Wheatstone professor of physics in the University of London, on "Empire Communication." Professor Appleton also gave the first of the Friday evening discourses at the Royal Institution, speaking on the work of the second International Polar Year, 1932–33.

AN Associated Press dispatch reports that the Japanese cabinet has announced the acceptance of an offer of the Rockefeller Foundation to donate 4,000,000 yen (about $1,240,000) for the establishment of an Institute of Public Health in Tokyo, for the training of hygiene workers. The negotiations with the government are said to have been begun twelve years ago.

THE annual meeting of the American Society for Testing Materials will be held from June 25 to 29, 1934, at Atlantic City.

Industrial and Engineering Chemistry calls attention to the fact that the nomination of candidates for the fourth American Chemical Society Award in Pure Chemistry, initiated by A. C. Langmuir, must be in the hands of the secretary of the society on or before January 5, 1934.

THE Achema VII Exhibition of Chemical Apparatus and Plant, Cologne, to be held from May 18 to 27, simultaneously with that of the German Chemical Trades Association and other leading trades associations and technical societies, will deal with exhibits of an unusually wide range. A number of conferences, scientific and technical lectures, special visits, courses for students, conducted tours through the "Achema" and other parts of the exhibition, have been arranged.

THE *Experiment Station Record* reports that under a new plan adopted by the board of governors of West Virginia University the divisions of the College of Agriculture will be reorganized under a single administrative head. All resident teaching of agricultural students, farm research and extension work will be coordinated under the direction of Dr. F. D. Fromme, dean of the college and director of the station, who now also becomes director of the extension division. J. O. Knapp, district county agent for the southern counties, has been appointed assistant director of extension; Russell H. Gist, district agent for the northern counties, state leader of county agents, and C. H. Hartley, formerly assistant director of extension, state leader of boys' and girls' club work. Offices for these officials will be maintained in Mor-

gantown. It is hoped by this plan so to reduce the costs of administration of the extension program that a larger portion of the funds may be devoted to the work in the counties, while the work of the college will become more closely knit with the research and on the extension program of the university. Reorganization in the field of biology has also been undertaken. Where formerly the various branches of this subject were distributed among several colleges of the university, most phases are now being coordinated under a single directing head and combined into one division of the College of Agriculture. Dr. C. R. Orton, formerly head of the department of plant pathology, has been given charge of the new department, which embraces all basic sciences related to biology, including botany, zoology, bacteriology, plant diseases and forestry extension.

A COLLECTION of invertebrate fossils, ranging from the Cambrian period to the Cretaceous has been received at Field Museum of Natural History as a result of a field trip recently completed in Pennsylvania, New Jersey and New York by Sharat K. Roy, assistant curator of invertebrate paleontology.

DISCUSSION

LIGHTNING PROTECTION FOR TREES

THERE is a wide difference of opinion as to the value of the lightning rod as a protective device. In my own experience I have been called on a number of times for advice as to the probable value of lightning protection for buildings of various types. My recommendations have not always been the same, and in each case have been based largely on common sense as related to the following principles and observations, upon which I believe that scientists are generally agreed:

(1) The protective value of a lightning rod is in its ability to discharge continuously and so prevent an abnormal rise of potential gradient as related to an overhead cloud.

(2) Preeminent height of a structure results in a high potential gradient at its top.

(3) The points of a lightning rod should be relatively sharp to permit steady leak and suppression of the high potential gradient.

(4) Congested areas, with many buildings of approximately the same height as in cities, have been observed to be relatively free from direct lightning strokes.

The lightning rod is not a certain preventive of a direct stroke. The protective value is directly related to the rate at which the rod points discharge. If the rate of discharge is not sufficiently rapid to suppress the building up of the potential gradient, the rod will often receive the direct stroke. If the structure bearing the rod is sufficiently high, it may even seriously influence the over-all potential gradient due to the cloud, and so receive a direct stroke, thereby actually "attracting" lightning. It is my understanding that during thunder storms there is always copious evidence, both at the Washington Monument and the Empire State Building, of steady discharges from the lightning rods, and frequently there are direct strokes.

The problem in connection with the protection of trees is even more obscure. This question was presented to me a number of years ago by Mr. H. Stevenson Clopper, a well-known arborist in Maryland. Maryland has a large number of very fine trees, some of them having historic interest and association. Mr. Clopper has a wide knowledge of them. I suggested to him the simple type of installation described in the following paragraphs. This note is to give the results of its usage over a period of seventeen years.

A 5/16 inch seven-strand bare copper conductor is attached to the tree trunk by galvanized or copper nails and is extended as nearly as possible in a straight line from the ground to the highest point of the principal leader of the tree which may be safely reached by the climber. At this point it is clamped to a 4 inch limb by means of a through bolt. Some 15 inches of the conductor above the clamp are untwisted with the strands pointing diagonally upward in all directions. In cases of large trees with several leaders, the conductor is carried to the extremity of each, the several conductors being joined in good electrical connection where the leaders converge. At the ground the conductor passes into a 3/4 inch iron pipe 11 feet long and this pipe is driven 11 feet into the ground. The conductor is rigidly attached to the pipe mechanically at the bottom and is soldered to the top at the ground level. In certain cases, owing to the size and number of tree roots, the ground pipe has been placed 11 feet away from the base of the trunk. In these cases the horizontal run of the conductor is also enclosed in iron pipe and buried a few inches below the ground level. The essential elements of the plan are simply those of providing an electrical conductor with pointed ends as near as possible to the top of the tree and running in as nearly as possible a straight line to a good connection with the earth.

The first installation was in 1916 on four large

tulip poplars. Since then the rods have been installed on Norway spruce, red oak, white oak, black hemlock, linden, elm and other types of trees. In all 61 trees have been protected. Nine of these trees had been struck one or more times before the installation of the rods. Since the installation of the rods no one of the 61 trees has been struck. Two cases have been reported in which a tree in the neighborhood of the protected trees has been struck, the protected tree remaining immune; in one case, at a distance of 280 feet, and in another at a distance of 150 feet.

The vagaries of lightning discharges and strokes are well known. The only certain and permanent protection would be some approach to the Faraday cage. The experience described above, however, would seem to indicate that the simple protective measures described afford a high degree of protection to trees.

J. B. WHITEHEAD
THE JOHNS HOPKINS UNIVERSITY

INDUSTRIAL JOBS FOR PSYCHOLOGISTS

AT the present time the number of academic posts is being curtailed, while in industry a drive to create jobs for the unemployed is in effect. It is logical, therefore, to expect that a certain percentage of the younger psychologists may find places for themselves in positions outside the colleges and universities.

Industrial executives do not telephone or write to college placement bureaus for a psychologist to fill a vacancy. Because of various popular misconceptions that have grown up around the name, psychology may mean anything to the uninitiated. In the average employment office it would not be an asset to announce that one is a psychologist. Since business men are not going to ferret out the academic psychologist and lure him into industry, the unemployed psychologist must apply for work in person.

For the employment interview it is a mistake to go armed with a thesis and to discuss in detail a problem that may be out of the range of interest or understanding of the man who is doing the interviewing. It is a mistake to emphasize a narrow field of training, or to stress that one is looking for an opportunity to continue a particular line of investigation. The chances are that the business man is not interested in that special problem.

The psychologist who is looking for a position in industry should not emphasize the fact that he wants to work on so-called psychological problems. He should apply for work as a college graduate and should not stress his psychological training any more than he would emphasize the fact that he had had several courses in English, history or mathematics. Throughout the depression young college graduates who have made favorable impressions when interviewed have found places for themselves on industrial payrolls. They have been willing to accept every conceivable type of employment in order to gain an industrial foothold. The psychologist should not scorn a job as clerk, salesman, truck driver, laboratory helper or machine tender if it is offered to him. As an employed individual, he is in a better position to get a job more to his liking at some later date than if he has no work at all. Many employers believe that the man who is working is a better man than the one who is unemployed. The moral, therefore, is: Get on somebody's payroll, regardless of the kind of work you have to do.

No matter what the job happens to be, the psychologically trained person should find situations of interest to him. Whether he is an introspectionist or a behaviorist he can observe himself in the rôle of a worker. If he is a believer in the principles of Gestalt he will find food for thought. As a social psychologist he will be in the midst of a dynamic situation where adjustments to his supervisor and to his fellow workers must be made. As an educational psychologist he will have a chance to study his own learning difficulties and the difficulties of others. Boredom, monotony and fatigue will be brought forcibly to his attention. Problems of motivation and individual differences are present in every work situation. The competent psychologist will see the psychological problems.

After he is employed, then whatever ability and training he may have should enable the psychologist to make the necessary adjustments to insure his own advancement and promotion. He will find that many of the problems of his employer are of a psychological nature, although they may not be recognized under that classification by the management. By analyzing his employer's needs and wants, and then suggesting common-sense solutions (without using the word "psychology" at all), many psychologists should be able to create industrial places for themselves during the coming decade.

RICHARD S. UHRBROCK
THE PROCTER AND GAMBLE COMPANY
IVORYDALE, OHIO

A NEW INTERMEDIATE HOST FOR FASCIOLOIDES MAGNA (BASSI, 1873) WARD, 1917

IN a recent paper, presented before the Helminthological Society of Washington (District of Columbia), the writer reported that the snails *Fossaria modicella rustica* and *Pseudosuccinea columella* had been demonstrated experimentally to be new intermediate hosts for *Fascioloides magna,* an important trematode parasite of cattle. Since this report, another snail, *Fos-*

saria modicella, has been demonstrated experimentally to be a satisfactory intermediate host for this fluke. The time required for the completion of the intramolluscan phase of the life cycle of the fluke was 58 days. In addition to the above snail hosts, laboratory-raised *Galba bulimoides techella* have been infected with miracidia of *F. magna,* and the development of the larval forms has been studied. The time required for the complete intramolluscan development was 60 days. This report validates that of Sinitsin (1930),[1] which was based upon incomplete studies.

The known intermediate hosts of *F. magna* have the following distribution, according to Baker (1911–1928):[2] *Fossaria modicella*—Eastern Quebec, Nova Scotia, and New Jersey west to Vancouver Island; Manitoba south to southern California, Arizona, Texas and Alabama; *F. m. rustica*—New York west to Utah, Nebraska south to New Mexico; *Pseudosuccinea columella*—Nova Scotia west to Minnesota, eastern Kansas and central Texas; Manitoba and Quebec south to Texas and Florida; and *Galba bulimoides techella*—Southern United States from Kansas, Missouri and Colorado to southern Texas; Alabama west to southern California and northern Mexico. The distribution of these snails corresponds to the known distribution of *F. magna,* which has been reported in North America from Arkansas, California, Illinois, Iowa, Kansas, Michigan, Minnesota, Montana, New York, Oklahoma, Texas, Wisconsin and the provinces of British Columbia and Alberta, Canada. At least one snail host is known to occur in each area from which the fluke has been reported. Since the distribution of known intermediate hosts provides a factor favorable for a wide range of distribution of the parasite, the appearance of *F. magna* in localities other than those mentioned above would not be surprising.

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WATERMELON SUSCEPTIBLE TO TEXAS ROOT ROT

ALTHOUGH the watermelon, *Citrullus vulgaris* Schrad, has been listed as completely resistant[1] and as immune or resistant[2] to the Texas root-rot disease caused by *Phymatotrichum omnivorum,* the plant has been repeatedly attacked, sometimes extensively so, in Arizona. Only a few weeks ago the writer observed a field of watermelons near Tucson which was badly spotted with the disease.

Recently Mr. Karl D. Butler, a graduate student in this department working under the direction of Dr. R. B. Streets, has proved susceptible the watermelon varieties, Klondyke, Iowa King, Iowa Belle and Pride of Muscatine, when they are planted in root-rot infested soil as well as when they are inoculated in field and laboratory. Butler used pure cultures in his inoculation studies. He found that single hyphae of the fungus may penetrate single cortical root cells, between two root cells, or that massed hyphae may be involved in the act of penetrating into the root of the watermelon. The parasite used both wedging action and softening of the wall in initial penetration.

Once inside the cells of watermelon roots, the fungus proceeded to destroy and absorb the contents. No indication of any protective substance, such as Moore believes to be present in immune monocotyledons and Turk's cap hibiscus,[3] was found. The nuclei of invaded cells were less than half the size of nuclei in adjacent, uninvaded cells.

Butler also noted the effect resulting from mixing cultures. Certain fungi and bacteria, grown in cultures with the root-rot fungus, were inhibitory in their action on the parasite. In cultures with *Trichoderma lignorum* hyphae of Phymatotrichum were checked or killed by direct attack of the former.

The paper here briefly abstracted is to be published.

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QUOTATIONS

MAYOR-ELECT LAGUARDIA ON RESEARCH

THE election of Major LaGuardia as mayor of New York City gives interest to his record in support of scientific research. As a member of the seventy-second Congress, speaking on December 28, 1932, in opposition to an attempt to eliminate an item of approximately $39,000 from the agricultural appropriation bill, he said in part:

Mr. Chairman: Science knows no politics. Are we in

[1] D. F. Sinitsin, "A Note on the Life History of the Large American Fluke, *Fasciola magna* (Bassi)," SCIENCE, n. s., 72: 1863, pp. 273–274, September 12, 1930.

[2] F. C. Baker, "The Lymnaeidae of North and Middle America Recent and Fossil," *Chicago Acad. Sciences Special Publ.*, No. 3, 539 pp., 58 pls., 1911; "The Fresh Water Mollusca of Wisconsin," *Wis. Geol. and Nat. Hist. Survey Bull.*, 70, Pt. 1, pp. 1–507, 28 pls., 202 text figs., 1928.

[1] J. J. Taubenhaus and D. T. Killough, "Texas Root Rot of Cotton and Methods of Its Control," *Texas Agr. Exp. Sta. Bul.* 307, 1923.

[2] J. J. Taubenhaus, B. F. Dana and S. E. Wolff, "Plants Susceptible or Resistant to Cotton Root Rot and Their Relation to Control," *Texas Agr. Exp. Sta. Bul.* 393, 1929.

[3] E. J. Moore, "Growth Relations in Culture of the Cotton Root Rot Organism, *Phymatotrichum omnivorum,*" *Phytopath.*, 23: 525–537, 1933.

this frenzy of economy, brought about by those who control the wealth of this country, seeking to put a barrier on science and research for the paltry sum of $39,113 out of an appropriation of $100,000,000? Science will go on when existing political parties will long have been forgotten.

I am sorry that the distinguished leader of the Republican Party in the House states that he is not versed in botany and publicly admits that he does not know anything of these terms or what it is all about; but, Mr. Chairman, it is indeed a sad day for the people of this country when we must close the doors of the laboratories doing research work for the people of the United States. The gentleman from New York says it is all foolish.

Yes; it was foolish when Burbank was experimenting with wild cactus. It was foolish when the Wright boys went down to Kitty Hawk and had a contraption there that they were going to fly like birds. It was foolish when Robert Fulton tried to put a boiler into a sail boat and steam it up the Hudson. It was foolish when one of my ancestors thought the world was round and discovered this country so that the gentleman from New York could become a Congressman. (Laughter.) . . . Do not seek to stop progress; do not seek to put the hand of politics on these scientific men who are doing a great work. As the gentleman from Texas points out, it is not the discharge of these particular employees that is at stake, it is all the work of investigation, of research, of experimentation that has been going on for years that will be stopped and lost.

The next day, when another item in the same bill was under consideration and the point was made that research in agriculture might well be curtailed because of current overproduction, Major LaGuardia said further:

I want to say to my colleague, the gentleman from New York, that I believe he is confusing the purpose of experimentation and research work of this kind with the immediate question of production. Surely we can not delay scientific research until the time comes when this country will need greater production. That indeed would be lack of vision. The very purpose of this kind of investigation and study is to have the information complete and ready when it is wanted, for it can not be developed overnight. . . .

Momentary overproduction is not the important question. The important question is the continuing of study to correct the defects of nature. The most fascinating part of human activity is its constant combat with nature in fighting the elements and in correcting the defects of nature. This has engaged the attention of mankind from the earliest times of which we have record. Assuming, if you please, that we now have overproduction and production of more commodities than the people of the country have ability to purchase, that is no justification for closing the doors of these laboratories, closing the doors to scientific research and stopping it. We must continue it. The population is constantly increasing. Some day the legislative branch of government will keep abreast of science. Why, Mr. Chairman, the most humble research scientist in the Department of Agriculture is at this time contributing more to his country than the most useful Member of Congress. The most humble engineer in the General Electric Laboratory or the Radio Corporation of America Laboratory is more useful to humanity than the most brilliant orator of this House. The trouble is that the legislative branch of government has not kept abreast with science. Government has lagged, science has advanced. We have permitted an unbalanced system of distribution to continue while science has increased production. We are living in the paradoxical state where there is great overproduction on the one hand and want and misery on the other. This is not the fault of science. This is the fault of government. This is the fault of men who have control of the governmental affairs of the country.

I want to plead with my colleague, the gentleman from New York (Mr. Taber), in his eagerness—and he is sincere and works hard on these bills—not to be too hasty in cutting down these appropriations to continue this scientific work, so that when the time does come we will have the information available. I repeat, if the science of government had only advanced along with the progress made in electricity, chemistry, mechanics, transportation and agriculture, we should not to-day find ourselves in the midst of a ruinous financial crisis. While science and the arts and mechanics were progressing, government was struggling along with laws and economics founded on principles accepted centuries ago. To-day we are still endeavoring to struggle along under construction and limitations of a constitution drafted and accepted at a time when steam had not yet been applied, before the railroads, before the telegraph, when electricity was entirely unknown, and in the days of hand production. Yes, gentlemen, science has forged ahead, and nothing that ignorance, petty politics, lack of vision, or hope to continue the old system may try to do can stop the onward march of science. So let not Congress seek to mitigate its shortcomings by attempting to adjust the universe with its own snail-like pace.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE DEVICE FOR WASHING MICROSCOPIC MATERIAL IN RUNNING WATER

SOME special techniques, for example, those for the study of the Golgi apparatus, require a thorough washing of small pieces of tissue for the removal of fixing reagents. This has always been connected with difficulties when more than one group of such objects (usually 3 to 4 millimeters in diameter) were washed in running water at the same time. Any device to this effect should require a minimum of manipulations, prevent air bubbles from coming in contact with the tissue and assure a constant gentle flow of water.

All that is necessary for the method recommended

here are pieces of cheese-cloth, pieces of glass tube, open on both sides and with smooth edges so as not to cut the cloth, and pieces of rubber tube, also open on both sides, which just fit around the glass tubes and around the faucet used for the water current.

First, the faucet above the sink is provided with a long piece of rubber tube. Then a piece of cheese-cloth is put over one end of a glass tube, and this end is connected with the long rubber tube on the faucet. Now the free end of the glass tube is held upward and a gentle flow of water allowed to expel all air bubbles. Then the material and a label is transferred into the glass tube and its other end covered with a piece of cheese-cloth kept in the right position by another piece of rubber tube. This in its turn may be connected with a second glass tube containing another piece of material, and this may be repeated any number of times. The result is that a long series of glass tubes separated by cheese-cloth and rubber tubes and each containing a piece of tissue are connected in a series with the faucet (see Fig. 1).

Intercalation of one or more Y-shaped tubes allows one faucet to serve more than one series of tubes containing material fixed in different reagents. In this way substances washed away from one piece of tissue can never touch material fixed in a different way.

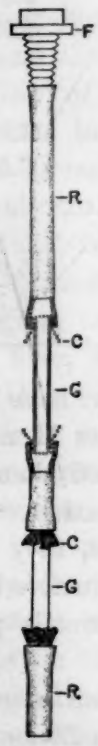

FIG. 1. Semi-diagrammatic drawing, showing the arrangement of the tubes. F, faucet; R, rubber tube; G, glass tube; and C, cheese-cloth.

Abstract: As a simple way of washing more than one piece of tissue at the same time in running water, it is suggested to put them in glass tubes separated by cheese-cloth and connected by rubber tubes to one another and to the faucet.

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ELASTIC FATIGUE AND CREEP OF COILED SPRINGS

THE writer tested springs of two types to obtain information on the rate of increase in length when loads were applied for long times. One type was made of steel piano wire. This type had turns of uniform size. The other type was the ordinary jolly balance spring, made of phosphor bronze and tapered.

During the 365 days that the 50 gm load was on the steel spring there was a gradually subsiding increase in length. This is not surprising, but the writer was surprised at the magnitude of the creep. It was about 3.5 cm (5 per cent. increase in length). At the end of the year the load was removed and replaced after a few weeks. During this rest period the spring became 1.2 cm shorter. Within six days after it was reloaded it had regained most of its loss in elongation (0.8 cm). Then the creep proceeded at a much slower rate, the displacement-time curve soon reaching about the same slope as it had shortly before the load was removed. The load was left about 6 months longer, but the creep was still noticeable at the end of this time. Such a spring would be entirely unsuited as a balance spring for many purposes, such as slow evaporation measurements.

The two phosphor bronze springs showed very little creep. With the load applied for six months the length increases 0.03 cm with one spring and 0.23 cm with the other, the former being about 0.08 per cent. The uncertainty of the readings was about 0.04 per cent.

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SPECIAL ARTICLES

EFFECTS OF ENVIRONMENTAL CONDITIONS ON LONGEVITY

IN line with a recent article in SCIENCE by Dr. C. M. McCay[1] some of the writer's experiments, planned to test the effects of environmental conditions on longevity, may be of interest. For the past year the writer has been working with the effects of certain environmental conditions on the duration of life in Cladocera. The animals used in the experiments to be mentioned here were Cladocerans from the

[1] C. M. McCay, "Is Longevity Compatible with Optimum Growth," SCIENCE, 77, 410, 1933.

stock of Dr. A. M. Banta. These animals are in many respects ideal for this purpose, chiefly because they reproduce parthenogenetically, and as pure lines (clones) exclude the probability of influence of any heritable factors for longevity.

The results presented are based on experiments with *Daphnia longispina* and *Moina macrocopa,* both of which have been reared in Banta's laboratories for many generations. They were cultured in manure infusion medium[2] which had been brought to a temperature of 25° C. previous to the introduction of the animals. This temperature was maintained throughout the course of the experiments.

The "normal" series was composed of animals reared in medium at a temperature which provides conditions as favorable as possible for growth and reproduction. The "retarded" series was composed of animals treated in every way exactly as were the normal animals except that their culture medium was diluted from 24 to 36 times with pond water so that growth was very slow and their reproductive rate low. The young selected as experimental animals were taken from large broods (20 to 35) produced by vigorous mothers, and were distributed evenly between the normal and retarded groups. Hence, all members of the series were either sibs or daughters of sibs. Each animal was confined to a wide-mouthed bottle containing approximately 100 cc of medium and was transferred to new medium after the release of each clutch of young. The young were counted and discarded. The summarized data for three such series are given in the table.

	No. mothers	Ave. no. young per mother	Ave. repr. life in days	Ave. no. broods per mother	Ave. no. young per brood	Repr. index	Average longevity in days
			SERIES I *Daphnia longispina*				
Normal	46	208.8	22.48	10.54	19.09	9.04	32.30 ± .401
Retarded ...	40	92.0	31.0	13.25	6.99	2.96	36.13 ± .490
			SERIES II. *Daphnia longispina*				
Normal	78	250.90	22.55	10.54	23.85	11.19	27.60 ± .356
Retarded ...	75	107.73	38.36	16.42	6.10	2.63	46.75 ± .503
			SERIES III. *Moina macrocopa*				
Normal	98	102.81	6.24	3.73	27.09	15.95	9.01 ± .125
Retarded ...	94	71.46	10.65	6.72	10.95	6.78	13.84 ± .240

Series I was started late in September, 1932, and consisted of 46 normal and 40 retarded animals. The retarded mothers produced fewer young and lived 3.83 (11.8 per cent.) days longer than did the normal mothers. A more significant analysis of their relative reproductive rates is obtained from the reproductive indices. The reproductive index is the average number of young per mother per day of reproductive life. The reproductive life is measured from the time at which the first clutch of eggs passed into the brood chamber until the last brood was released. In this series the normal animals produced on the average 6.08 more young per day than did the retarded of the same series.

Series II, started in November, 1932, and consisting of 78 normal and 75 retarded animals, gave similar results with an even larger differential between the two groups. The retarded mothers released 8.46 fewer young per day than did the normal. Their duration of life was 19.15 (68.4 per cent.) days longer than that of those reared under favorable conditions. The increased longevity of the retarded over the normal may in part have been due to reproductive exhaustion since Series II normal mothers produced more young per brood than did those of Series I. Even though the duration of life of the normals of Series II was shorter, they showed very nearly the same length of reproductive life and exactly the same average number of broods per mother as did those of the first series.

Series III, of *Moina macrocopa,* a much shorter-lived Cladoceran than *D. longispina,* was started during March, 1933, and was composed of 98 normal and 94 retarded mothers. Here again, animals living under poor food conditions have a lower rate of reproduction and a longer life than those under favorable conditions.

Lowered reproductive rate is not the only result of inferior environmental conditions. Mothers in diluted medium do not reach sexual maturity as soon nor do they release clutches of young as frequently as those in undiluted medium. The growth increment is especially decreased, the retarded animals never attaining the same size as do the normal.

[2] A. M. Banta, "A Convenient Culture Medium for Daphnids," SCIENCE, 53, 557, 1921.

McCay cited evidence which he believed indicated that longevity in the rat is increased by limited diet. The present controlled experiments with Cladocera seem to demonstrate (1) that poor environmental conditions influence rate of development and reproduction in several different ways and (2) that longevity is influenced by environmental conditions. In the present case it is greatly influenced by suboptimal conditions. The writer's experiments are being continued.

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ARTIFICIALLY INDUCED CROSSING-OVER IN MALES OF DROSOPHILA MELANOGASTER

SOME of our previous work on the artificial induction of breaks in somatic chromosomes in *Drosophila melanogaster* by means of x-rays[1] makes it highly probable that breakage of chromosomes in the somatic tissues of males occurs less easily than in those of females. On the supposition that this peculiarity of the male is also present in spermatogenesis, it may be expected that crossing-over is not absolutely impossible in the male, and that its absence is merely due to this low liability of male chromosomes to breakage. There is reason to expect, therefore, that crossing-over might be brought about in males by applying the same agents that increase crossing-over in females. We know that for females, temperature extremes[2] and x-rays[3] considerably increase crossing-over in the central region, *i.e.*, near the attachment point of the spindle fiber, of the long autosomes (chromosomes II and III). If our supposition that crossing-over is possible in males is correct, we may expect that these same agents will induce crossing-over in the central region of the chromosome in spermatogenesis also. In my experiments heterozygous males of *Drosophila melanogaster* in the second day of the pupal stage were placed in test-tubes and subjected to the action of x-rays (dosage – 4000 r.). About 4½ to 5 days later the adult males were crossed with homozygous females suitable for crossing-over tests. The multigenic second and third chromosome heterozygotes were chosen for the experiment.

In one of the series, the males carried in one of the second chromosomes the recessive genes atrura (a gene inducing a dark brown coloring of the eye, locus 18), plexus (inducing a plexus in the wing-veins, 100.5) and speck (inducing a black speck at the base of each wing, 107), and in the other one the normal allelomorphs of these genes. The 561 flies produced from this experiment gave 22 (3.9 per cent.) cross-overs between atrura and plexus (11 atr and 11 px sp). Another similar experiment, differing from the first in the structure of the males $\frac{S + Br + +}{+ atr + px\ sp}$; S = Star, rough eyes, dominant and lethal in homozygous state, locus 2; Br = Bristled, extra sternopleural bristles, dominant and lethal in homozygous state, 21), was carried out with 830 offspring, including 17 (2 per cent.) crossovers between Bristled and plexus (9 atr and 8 S Br px sp). The control series, consisting of 1,756 flies, did not give a single case of crossing-over. In a third experiment, producing 988 flies, the x-rayed males had the structure $\frac{S\ Br\ +}{+\ +\ bw}$ (bw = brown eyes, recessive, 105) and 2 cases of crossing-over between Bristled and brown (1 S Br bw and 1 wild type) were obtained. In a fourth experiment with the second chromosome, the structure of the male being $\frac{S\ Br + + +}{+\ +\ b\ cn\ c}$ (b = black body, recessive, 48.5; cn = cinnabar eyes, recessive, 57.5; c = curved wings, recessive, 75.5) 142 flies gave two cases of crossing-over between black and cinnabar (2 S Br cn c).

In one experiment with a six-gene third chromosome, yielding 834 flies, (structure of the males = $\frac{ru\ h\ st\ p^p\ ss\ e^s}{+\ +\ +\ +\ +\ +}$; ru = roughoid, irregular eye facets and hairs, recessive, 0; h = hairy, extra hairs on scutellum, recessive, 26.5; st = scarlet, cinnabar eyes, recessive, 44; p^p = peach eyes, recessive, 48.4; ss = spineless, bristles very short, recessive, 58.5; e^s = sooty, dark body, recessive, 70.7) there was not a single case of crossing-over. But in a second experiment with the same chromosome, yielding 257 flies, the sires were males from the line atr px sp, which had given a high percentage of crossing-over in the second chromosome (see above), and 5 cases of crossing-over between scarlet and peach were obtained (2 ru h st and 3 p^p ss e^s). It may be that in the first experiment with this third chromosome certain conditions obtaining in the other experiments were absent. Nevertheless, it would seem, from a comparison of all the experiments, that the artificial induction of crossing-over in the male is accomplished with unequal ease in different lines. This problem must be investigated further.

A genetic analysis has shown that the observed crossing-over in males is not imaginary and is not the result of chromosome aberrations, *e.g.*, translocations, duplications, deficiencies or mutual translocations between two homologous chromosomes in non-homologous points. A cytological examination, for

[1] Friesen, 1932, *Biol. Jour.* (Russian), I, Nos. 5–6.
[2] Plough, 1917, 1921.
[3] Mavor and Svenson, 1924, and Muller, 1925.

which I am indebted to Dr. I. E. Trofimoff, has also revealed a normal chromosome complement.

The fact that in all cases where it could be proved, the crossing-over in males took place in the central region of the chromosome, *i.e.*, in the same region where crossing-over is increased by x-rays in females, seems to indicate an identical mechanism of crossing-over in both sexes, and shows that the absence of normal crossing-over in males is not due to its impossibility during spermatogenesis.

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THE ACTION OF AMMONIA ON PHENOLS

THE recent article by Van Slyke and Hiller on the determination of ammonia in the blood,[1] in which the blue color developed with ammonia, phenol and hypochlorite is utilized, suggests comment from us, since we have been engaged on a somewhat analogous problem.

It has long been known that ammonia (or one of its salts, or some of its organic derivatives) gives an intense blue color with phenol in the presence of an oxidizing agent, such as sodium hypochlorite. The mechanism of this reaction has not been fully cleared up, though it is believed by some that quinonechlormid is one of the products.

Phenols, in general, give various colored solutions with ammonia (or its salts) and an oxidizing agent; and from our own experience, it may be suggested that for a qualitative test, the reaction compares very favorably with the ferric chloride test. We were hopeful that one of these phenol-ammonia color reactions might lend itself to the quantitative estimation of ammonia in urine. Orr[2] had already used phenol itself for this purpose; and for a time we confined our attention to the possibility of using some phenol other than phenol itself. Some 20 different phenol and phenol-like compounds were investigated. Of this number, thymol held out the most promise; but actual comparison of thymol with phenol forced us to the conclusion that the color developed with the latter was more stable and more pronounced than that developed with thymol; and that, therefore, phenol itself was more adapted for use in quantitative colorimetric determinations.

Incidentally, we have had occasion to repeat Orr's work, and to confirm it in its main essentials. We first made up solutions of ammonium sulfate of known strength and estimated the ammonia colorimetrically by adding phenol and sodium hypochlorite, as outlined by him.

[1] *Jour. Biol. Chem.*, 102: 499, 1933.
[2] Orr, *Biochem. Jour.*, 18: 806, 1924.

Original solution mg per cc	Estimated
.025	.026
.05	.05
.06	.06
.07	.07
.08	.08
.09	.09
.15	.16
.20	.20
.25	.24
.30	.28

We next determined the ammonia in several samples of urine (obtained from patients at the hospital) and compared the results with those obtained by Folin's aeration method.

Same	Folin method	Colorimetric estimation
1	0.36	0.39
2	0.27	0.26
3	0.31	0.32
4	0.48	0.51
5	0.54	0.54
6	0.26	0.32
7	0.44	0.45
8	0.49	0.49
9	0.50	0.51
10	0.38	0.37

It will be seen that the phenol-ammonia method compares very favorably with the method devised by Folin.

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